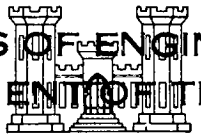
CENTER FOR ECONOMIC STUDIES
of the
INSTITUTE FOR WATER RESOURCES



CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

CENTER PAPER 72-1

PROCEEDINGS OF CORPS OF ENGINEERS
ECONOMISTS CONFERENCE
Galveston, Texas
22-24 March 1972

Center Paper 72-1

Center for Economic Studies
Institute for Water Resources
U. S. Army Corps of Engineers
2461 Eisenhower Avenue
Alexandria, Virginia

FOREWORD

This publication contains the proceedings of the Conference of Corps Economists held 22-24 March 1972 at Galveston, Texas. It is a collection of the general remarks, problem statements, status reports of current research, summaries of workshop discussions and contributed papers presented at the conference. While the conference transactions cannot and are not intended to provide ready answers to the many important problems and issues in the evaluation of water resource development, they do contain many new and innovative ideas and concepts which should be seriously considered for application or for future research.

The entire conference was predicated on the belief that the economists working for the Corps have an important role to play in planning the Nation's water resource development programs. The need for active participation in all phases and areas of project planning by Corps economists has been eloquently expressed in the general remarks by BG Cooper, Col Werner, Mr. Harrison and others, and in the papers presented at the conference. It is hoped that the exchanges of ideas and perspectives at this conference will assist the economist in this role and stimulate the development of a more meaningful research program.

JAMES TANG
Conference Coordinator

PROCEEDINGS OF CORPS OF ENGINEERS ECONOMISTS CONFERENCE

Galveston, Texas, 22-24 March 1972

III. Contributed Papers

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SECTION I

GENERAL SESSIONS PRESENTATIONS

REMARKS BY THE DIRECTOR,

BG KENNETH B. COOPER

My purpose in talking to you this morning is to give you an idea of where we are and where we are going in the Civil Works program.

Before getting down to details, I have a few comments on the conference itself. Some of the people in OCE have been skeptical of the value of this first meeting of Corps economists. I trust the formal agenda will be rewarding, but I am sure that there will also be great value through the informal discussions which you will have. In many meetings comparable to this, the informal discussions constitute the unofficial raison d'etre for the meeting. We have limited attendance here to essentially one per Division and District. The purpose was to reduce the cost and to give more people an opportunity to speak in the smaller group discussions. Since we have limited attendance, I ask each of you to brief your colleagues back home in some detail on the results, good and bad, of this conference.

We have with us today, Dr. Jack Sheaffer and Dr. Jim Tozzi, who I consider are part of the Corps. We also have about a dozen friends whom we list as consultants. This is an in-house meeting so don't be afraid to speak up and say what you think. You might look upon this as an intra-Corps public participation program.

But back to something more specific, in <u>flood control</u> the trend in Corps Civil Works planning is away from structural solutions. This trend is not just a result of the enhanced environmental awareness, but also

a result of economic considerations. The 7% discount rate in the Water Resources Council's "Proposed Principles and Standards" was primarily to reduce the portion of the Federal budget spent on water resources development. Even if the proposed opportunity cost of money and discount rate are eliminated, this objective will still remain. The Flood Plain Management alternative to structural solutions must be stressed even more than it has in recent years.

In navigation the trend is toward regional considerations. The deep draft port is an example. The Corps can and will lead the way in the study of deep draft ports. Because of the regional considerations, the division offices must do more than just coordinate studies done by the districts.

In the area of beach erosion there has been a tendency for planning to be handled separately within Divisions or Districts and by CERC and the CERB. I think this will change. The National Shoreline Study recently completed showed clearly that there are extremely complex institutional and political problems to be solved in this area of the Corps' activities.

With regard to water supply and recreation, I believe these will remain ancillary project purposes. We have some significant problems involving how much we must have versus how much we would like to have. The environmentalists' solution to water supply is to use less. If we don't build some more dams, this solution will be forced on us. But I am not sure this is what the majority of the public wants.

The newest, most prominent, role of the Corps is in Urban Studies. By the end of this calendar year we may be involved in 25 or more. Dr. Sheaffer and Dr. Tozzi clearly deserve most of the credit for getting the Corps involved in this program. Urban studies, of which wastewater management studies are a lesser included part, offer us a fine opportunity to be of public service which is, after all, our major purpose in life.

We in the Corps do not have all the answers, but we can point with pride to past accomplishments. One of the primary sources of the strength of the Corps lies in its competence at the local level. Many organizations preach decentralization of authority and responsibility; we practice it.

In closing, let me extend to you my good wishes for a successful conference. I asked General Koisch if he had any words of wisdom for you. He had only two, "be practical". I am sure you all can be. I know many of you have constructive solutions to our problems and issues but keep in mind that the final test is whether you can get the field to understand and use your solutions.

CONFERENCE OBJECTIVES

I. Introduction.

This meeting of the economists of the Corps is jointly sponsored by the Office of the Chief of Engineers, the Board of Engineers for Rivers and Harbors and the Center for Economic Studies of the Institute for Water Resources. It is appropriate that these three elements of the Corps join in this meeting for each deals with the problems we will discuss, but from perspectives which vary greatly. This meeting will make possible, we hope, a better understanding of these perspectives and their significance in the day to day work and in the future plans of the Corps of Engineers.

You are all familiar to a considerable degree with the Office of the Chief and with the Board of Engineers for Rivers and Harbors. Later this morning you will hear of some of their present problems and concerns. The Institute for Water Resources and its Center for Economic Studies is not so well known. For this reason, I will review, briefly, the origin and purpose of this office.

II. Origin and Purpose of IWR Center for Economic Studies.

The Institute for Water Resources was organized in April 1969. The Center for Economic Studies had functioned for some months prior to the development of the Institute, being an outgrowth of the Economics Branch of the Planning Division of the Office, Chief of Engineers. Thus, our Annual Report for 1971, just issued, is a report of our third year of work.

For many years, prior to the organization of the Institute, the Planning Division, the Policy and Analysis Division, and others in the Civil Works Directorate, recognized that there was need to establish a group outside the day to day pressure of administration and free to look into some of the persistent and complex problems of resource planning beyond the capability of those charged with day to day management.

What was this group to be like? An Ivory Tower was not envisioned, although there was recognition of the need for freedom and time to think and to bring researchers of diverse competence together. But it was also recognized that this new group would need to be thoroughly familiar with the needs of the Corps planners and with the resource problem which the Corps faced. The idea of detachment in the sense of other-worldliness was not involved. As research for the sake of research was to be avoided. a middle ground was sought, one in which creative, even original thinking, could be brought to the problems faced in the Corps--the problems of a recurrent character, and those which grew out of exceptional circumstances and conditions and which required specialized treatment to identify their nature and to develop solutions. New ideas and approaches were not to be ruled out but were to be encouraged and tested for usefulness.

In brief, the purposes of the Center for Economic Studies are to identify these economic problems of natural resource use, conservation and development which fall within the field of interest and responsibility of the Corps of Engineers in carrying out the duties assigned to it, and to bring to the research topics selected the best available talent and

to carry out effectively research directed specifically at answering the questions and solving the problems coming before the Corps. A review of research which others are doing is also an essential duty of CES. We must recognize that while CES is new the experience of the Corps in economic studies is one of the largest among the natural resource agencies. These duties are, of course, complex. There are many problems where research is not the essential need required in development of solutions. The task of determining, and arranging in priority, the problem areas where research (within the limits of time and funds available) is likely to be rewarding is a task where the Institute and the Center require active cooperation from many elements of the Corps. Indeed, you will recognize that both of these objectives require a cooperative approach. I will have more to say in a moment on the potential relationship between Division and District staffs and IWR as the research plans of the Center for Economic Studies unfold.

There are other duties of the Center, including serving as a clearinghouse and depository for economic studies conducted throughout the Corps; consultation with other elements of the Corps and with other agencies and with the Water Resources Council; monitoring of research underway for application to Corps problems; development of training and career development programs for economists, planners and others; as well as development of rosters of outside talent available to the Corps as needed.

III. Economics in Water Resources Planning.

Most of our discussions will center about specific fields of Corps responsibility but I believe that we should briefly summarize some of the

fundamental concepts which economists hold and the steps which economists take in the development of water resource plans and in the economic and social evaluation of resource programs and projects. I mention the professional thinking and tasks of the economists for, as Corps economists, it is our responsibility to be good economists. It is our objective in the Center to help bring the very best economic talent and talent in related fields to the Corps of Engineers and to direct it toward implementing planning problems, problems which are more often than not interdisciplinary.

Much economic thinking starts out with consideration of demand and supply, for commodities with economic value are scarce and their value is determined by the forces of demand and supply operating in a market or through institutions which serve as proxies for a market. In the case of water resources there is rarely a well developed market, so the resource economist must learn how to observe indirectly changes in demand and supply forces and thus in value. The art of observing such changes and measuring them is at the heart of much of the research of the Center for Economic Studies and is certain to be central in many of our workshop discussions. Let me illustrate: Much of our work in water supply and quality is concerned with developing methods for observing how changes in quantity or quality affect the demand (and the value) of water and how changes in one of these affects the other. In other words, we wish to determine the elasticity of the demand for water and understand the trade-offs which are made between quality and quantity. Similarly in the field of recreation we believe that advances in understanding must come through better knowledge of the demand for recreation. Here, as elsewhere, it is important to

separate elements of demand from those of supply. Where the demand and supply elements are intermingled and transposed in the analysis as happens in many current studies of recreation, there is little hope for valid understanding. Other examples, close to the work of the Center, can be found in the preparation of estimates of resource "needs" as required for the PPB system. Here again the "needs" must be understood in their economic sense if they are to be successfully used as planning guides. The results of demand estimation find expression in the benefit analysis. The cost side is also important. Here the problem of externalities remains the most serious obstacle. Economic studies show that many costs are outside the economic system as it has traditionally worked, as when a firm places waste in a stream and leaves to the public the cost of clean-up. There are many types of externalities and many of them are gradually being better understood and we can expect cost and benefit estimates to begin to reflect both positive and negative aspects. Our understanding of national and regional economies will be significantly improved when these external forces are brought into consideration. The economic staff of the Corps must be prepared for these changes and the analysis which will proceed and follow them.

Another concept which comes into play in much of the Institute's work, and indeed into the work of all economists, is that of maximizing net benefits or other measures of value. Now that we have entered rather fully into the era of multiple goals as well as multiple purposes and alternative means, the concept of maximization is not easy to achieve and demonstrate in practice. On this topic two good economists have written:

"One would be hard put to identify a single instance related to the development or utilization of water resources wherein those who make decisions bear all the costs and receive all the benefits. The norm in our complicated interdependent world is for decision-makers to manage in an institution environment of suboptimization and externalities. The exception, not the norm, is a situation in which all costs and all benefits are internalized and thus taken into account in the decision-making process. Consequently, the signals to which our economy responds are distorted, and the equilibrium toward which we presumably trend are not characterized by socially optimum allocation of resources and utilization of water or other natural resources." 1/

The years immediately ahead are not going to be easy ones for economists or for resources planners generally. Some of the accepted values, many of the approaches and much of the institutional structure on which natural resource economists have depended are proving inadequate. The value of economic growth has been exaggerated, welfare has been measured by the quantity of goods and services produced with little reference to composition, quality or distribution in both private and the public sectors. National income and GNP are imperfect measures of the net product of our economy. To a considerable degree the current flow of goods and services, as measured by GNP, represents a transformation and consumption of irreplacable natural resources. Our capital stock is depleting but this is not shown in our statistics. Likewise, population growth has been held to be an assumption and sometimes a goal, but today many planners question the efficacy of inducing economic activity and population growth as a step toward social and political progress. The economics of a stable population with the accompanying change in age distribution would amount to a revolution for both the public and the private economy.

Competition has been looked on as the principal means for accomplishing the necessary coordination of economic activity among individuals and groups.

1/ Fischer, LLoyd K. and Baker, Maurice, "Institutional Constraints to Achieving Maximum Beneficial Use of Water Resources in the Great Plains," The Role of Water Resources in the Economic Development of the Great Plains, Great Plains Agriculture Council Seminar, July 22-23, 1971.

There is need for competition; it has many beneficial effects but in the field of natural resources where externalities are very important, reliance on free competition has led to some socially undesirable ends. It has led to acceptance, to a considerable degree, of the proposition that those who are in a position to shift the cost of their own actions to others, or the benefits of the actions of others to themselves, have some sort of divine right to retain their gains and to perpetuate and enhance their advantageous position. 2/, 3/ The result of this has been summarized by Fisher and Baker:

> "...those who have been damaged by the action of others have usually been considered to be the victims of their own ignorance or indolence and thus not worthy of public protection. The responsibility for adjustment and accommodation has customarily rested on those who are adversely affected by the actions of others and not on those who are taking the actions. The rationalization for not taking public action to redress inequalities has been that opportunities for great gain and the coercion of poverty provide incentives necessary to the working of our economic system." 4/

Corps economists are not alone in being painfully aware of the rather widespread discontent with the way that much of our socio-economic system works. This discontent takes many forms. Any full analysis of the sources and consequences of the present disillusionment and alienation would be far beyond our purpose at this gathering. But to fail to recognize this aspect of our times would also be a serious deficiency in our program. Accordingly, the following remarks are meant to draw a rough outline of the problem as I see it.

Those who challenge our social system generally accuse the capitalist system of suppressing civilization's deeper values. Even the most ardent supporters of the free market economy do not deny that this is true to a considerable degree. Galbraith achieved world wide fame and praise with

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2/ Ibid, p. 127.

3/ Long, Erwin J., "Freedom and Security as Policy Objectives," Journal of Farm Economics, Vol. 35, No. 3, August.

4/ Fisher and Baker, op. cit., p. 128. 1953, pp. 317-22.

his analysis of the defects of the Affluent Society.

Repeated and convincing questioning of the legitimacy of the prevailing economic system has encouraged the always underlying alienation of man to become overt as it has today, and similarly at a number of crucial periods in the past times like our own of questioning and transition.

Why is man's special alienation always ready to assert itself? This is, of course, an enormous question. A full answer may never be found. In the most simplified terms: Man is split between his individual ego and the rest of existence. He cannot do and be everything at once. Thus, he must make choices. Almost every choice involves giving up some other goal or pleasure. Society, in order to endure, forces man to make many adjustments--to give up much that he wants. He sees his own potentialities and the chance for their realization being slighted. All this is bearable when there is a strong belief that the system is a legitimate one; that the sacrifice is necessary, meaningful.

Today many men question the system. They see themselves slaves to the production process turning out goods which are marketed through high pressure advertising and often seeming to have no purpose but to keep the factories going. Ever-increasing production and consumption of goods apparently does not lead to happiness or a good environment for living. The nature of the dissatisfactions we see about us today make it obvious that our economic process cannot save itself by success. As Professor Schumpeter, the great Harvard teacher, said, "capitalism would not be destroyed by its failure but by its success."

What can the economist, particularly the resource economist, do toward correcting this imbalance?

1. We must look closely at the meaning of scarcity in the economics of today.

2. We must assess the concept, practices and above all the appropriateness of economic growth to our national and regional economies.

3. The meaning of the concepts covered by the word "need" must be better understood, particularly in relation to the term "well-being."

4. The meaning and means for realizing multi-dimensionality in our lives must be evaluated and the road block to its achievement removed, to the degree possible.

Why must these steps be taken? Because: today many people believe or at least suspect that the real cost of achieving economic growth is quite often at the expense of those aspects of life which are not commonly included in the definition of economic goods but which are desirable, even vital. To say this another way: the concept of economic growth (as we now see it practiced) and the concept of equilibrium or balance in human lives and activities reflects the inner conflict in free enterprise-capitalism. This conflict must be resolved.

The events we see and the fears we share are not new. The economic system we have created has fallen from grace a number of times. Each time that its legitimacy has been seriously questioned, its champions have offered new rationalizations, for a time accepted and in turn defeated.

One of the earlier rationalizations of capitalism was the Calvinist identification of divine blessing with material success. The "puritan ethic" did long service with its message that the chosen were the successful. It proved a strong lever to shift man's thoughts at a crucial time from unprofitable pursuits, whether seeking for spiritual grace, or mundane

power and luxury, in the direction of frugality and capital accumulation.

At a later time this concept ceased to be acceptable. Adam Smith put in its place the concept of invisible laissez faire, working through the mechanism of competition, to achieve common goals.

But Smith's optimistic doctrine did not stand up in the face of the hardship brought about by the industrial revolution. Competition gave way in the face of oligopoly and market power.

In our own time we saw the strains on our system as the Depression of the 1930's grew worse and world-wide. Keynes then appeared and showed the governments of the world how to enter the market and through spending get employment started upward.

Now we have another crisis brewing, but of course it is a different kind of crisis. What is needed? The answer depends upon what you believe are the stable components in the situation. Ten years ago almost every social problem was blamed on insufficient growth. Now we are at the opposite end of the pendulum and we are blaming our problems on growth or at least on excessive emphasis on GNP. What in today's analysis will last? It is not at all certain. The persistence of great poverty in the midst of wealth appears likely to continue for a long time, and appears to be at the root of many troubles. Resource depletion and environmental neglect also seem to be here to stay as important problems for many years.

How can these problems ever be solved without the means which rapid economic growth makes possible? Everyone knows by now how enormous is the investment required to raise a few families from poverty to firm places in the economy. Solution of the environmental problem also requires the application of great amounts of capital if we hope for genuine restoration

and a stop to degradation. The resource economist is certainly going to have to make up his mind soon on the growth rate essential to successful attack on poverty and environmental problems. It seems to me that much of the confusion and doubts cast on the value of growth measured by GNP stems from the frustrated hope that a steady increase in GNP will increase the absolute size of everybody's share and thus take a lot of the sting out of the immense variation we have in personal incomes. This belief is doomed to failure; it neglects all the qualitative aspects of economic life. Income distribution in a democracy is not solely an economic problem but a matter also of psychology, morality and justice.

Since many of the problems of the "Affluent Society" stem from the zone where the public and the private economies meet, it may be appropriate to ask what can be done to bring about a better appreciation in both the public and private sectors of the need for close coordination of efforts. We will find many different opinions on the desirability and on the value of business-government cooperation. There are clearly those who like Milton Friedman at the University of Chicago, think that business serves best when it sticks to its task of allocating resources by maximizing profits. This may prove correct but it leaves to government burdens that it may not be able to carry alone. There is at least the possibility that business might be brought into closer ties with government through the development of new levels of corporate responsibility. This could involve responsibilities for employment of the unskilled and their training, clean up of the environment,

and active contribution to many social services and causes. On this point I want to quote from Professor Henry C. Wallick at Yale: 1/

> "For the business executive, corporate social responsibility holds out great potential rewards. He is promoted from employee of the stockholders, hired to maximize their profits, to arbiter among competing interests. Many young people who are shying away from business careers would be attracted to this enhanced role.
>
> The stockholder, too, comes out well. Executives hesitant to accept social responsibilities, to be sure, like to wonder publicly whether it is appropriate to spend stockholders' money for nonbusiness purposes. But who said this money had to come out of profits? That is true so long as social expenditures are incurred by a single firm that cannot raise its prices. If all firms do it, the cost of doing good will become a cost of doing business, and will be charged to the customer.
>
> And the public? If we believe what we say about a pluralistic society, about limited government, about decentralization, everybody will benefit if more of the work of improving the world is handled by business and less by government. The job will get done at minimum cost instead of with maximum bureaucracy. The ultimate manace of Big Brother in Washington will be pushed back.
>
> An attempt to overcome alienation along these lines is more than an exercise in dialectics. Accepting broader social responsibilities means a genuine change in the system. The ultimate outcome of such change, of course, is never certain. But at this point in time, confronted with the particular sources of alienation that we face, it is difficult to visualize a more convincing way of restoring the legitimacy of capitalism."

I do not mention these defects in our economic and social system without realizing that our system also has great virtues and that in many respects it serves us well. Because it is a good system we must preserve it by correcting its defects as they become apparent. The role of the natural resource economist will be vital here for it is along the margin between the private and the public sector that real changes in values and methods are needed. Our institutions have lots of vitality. They can stand the shock of alteration needed to get some real income flows started for the benefit of all citizens through economically enlightened proper management of public business.

1/ Wallick, Henry C., "How Can Business Rescue Capitalism," Fortune Magazine, March 1972, p. 124.

IV. Objectives of Meeting of Corps Economists

A meeting such as this may, of course, serve many purposes. To a degree each person will look on it and receive value from it in accordance with his own unique knowledge, experience, and perceptions. Nevertheless, I will state some of the objectives that I believe should be served, hoping that they will act as a stimulus and that before the meeting is over we may each have broadened our conceptions of what can be gained as well as what cannot be gained from discussions such as these.

New Priorities and New Fields of Work:

These are times of rapid social change. Governmental programs are feeling this especially as many of today's problems fall in the governmental sector of our economy and society. Throughout this meeting I hope that each of you will keep in mind the possibilities of new missions, new concepts and approaches. These lead to opportunities for thought and research on how to achieve real gains in social welfare. Our program this morning provides for remarks from Dr. James Tozzi and Dr. John Sheaffer of the Office of the Secretary of the Army. Mr. Tozzi will comment on Program Priorities. Mr. Sheaffer will reflect on the Corps Involvement in Urban Studies. The problems of priority are at the heart of all planning and research programs. It is well to face the priority problem early in our discussions. We will turn to it many times. Likewise, urban problems will increasingly come to the forefront in our planning and research. Over 50% of the U.S. population is found in three great metropolitan complexes--Boston-Washington; Chicago-Pittsburgh, and San Francisco-San Diego. We must learn all we can of urban needs and

especially how water resources problems relate to other urban problems and plans. For the future is largely an urban future and we know that social and economic development is not the result of any one program but is a response to a carefully designed package of programs and plans.

Planning Problems and the Administration of the Corps:

All of us have the obligations of trying to improve the planning process. The role of the economists in planning is today widely recognized. Needs have grown more complex, so have resource plans and the analysis required to develop them and to display their benefits and costs.

The OCE planning staff will lead a panel in discussion of the Principles and Standards of the Water Resources Council. They have just come from the public hearings held in Washington to sample the public reaction to these new guidelines for water resource planning. All Corps offices are concerned with these planning guidelines and certainly all Corps economists will be involved in their implementation.

Also to be discussed are the Section 122 provisions of the Flood Control Act of 1970 that the Corps explain the adverse effects of projects and programs and offer ways to offset or ease them. Here again is a planning topic where the economist has a special interest and role.

Also to be presented by OCE staff are some new approaches to flood control evaluation. Here, too, there is a direct and personal concern on the part of economists.

Mr. Phippen of OCE Planning Division will address the subject of the economic cost and benefits of flood plain regulation, contributing to our session this afternoon on flood control and flood plain management.

The Board of Engineers for Rivers and Harbors:

Mr. Schiffers and Mr. Adams of the Board of Engineers for Rivers and Harbors, are here and will take an active part, explaining their own research interests and bringing their thoughts to bear, we hope, on a wide range of subjects presented by others.

The IWR, Center for Economic Studies:

The interest and purpose of the Center for Economic Studies in this meeting may be summarized as follows:

1. To present to Corps economists the current program and accomplishment of the Center.

2. To summarize the plans for research in Fiscal Year 1973, and to get the ideas and opinions of Corps Economists as an aid in developing plans for the five-year period, FY 74-78, covered by the next budget.

3. To explain how the Institute operates, the major constraints it works under and the opportunities it sees for contributing to planning.

4. To discuss the way that the Center has selected fields and topics for intensive study.

5. To discuss the relationship of the Center to the Divisions and Districts of the Corps and to other Corps elements.

On each of these topics we will want to get the reactions you have for improving the present program, for new topics that you feel are needed to serve the responsibilities of the Corps, for improving the procedures of the Center, and for establishing new or continuing old working relations with the Districts and Divisions of the Corps. In the General Sessions IWR staff will discuss its program. The workshops will provide the setting in which Division and District economists can fully express and exchange ideas on the Center's program and on new work which should be considered for the future. I want to emphasize here that the Center has

greatly profited from its cooperative research with Corps Divisons and Districts. We certainly want to continue and enlarge this relationship. The Center's FY 1974 budget will soon be due. We are especially anxious that the new budget documents reflect the interests and priorities of the field planners to the degree consistent with our other responsibilities. In every way possible we wish to encourage a dialogue which is truly two-way, a dialogue which will continue long after the meeting is over.

I have emphasized the work of the Center for Economic Studies. Fortunately, we have Mr. McDonald here from the Center for Advanced Planning in IWR. His remarks tomorrow will lend balance to what I have said.

At this point I wish also to say that we have with us a number of consultants with diverse talents, real and imaginative. Their presence lends a welcome interdisciplinary air to this meeting of economists.

V. Range of Interest of the Center for Economic Studies

A word should be said about the scope of the Center's interest. Basically, it is as broad as the economic problems which Corps planners face. Clearly it covers the economic aspects of the major purposes which the Corps serves, flood control, hydroelectric power, water supply, inland navigation, port development and so on through the long list. But there is an aspect of the Center's interest not well covered by this listing of functions and the specific problems associated with each. We are interested in the role of economics in forming better plans. A wealth of tools have been developed in the economic area. We are interested in developing cost sharing programs which truly contribute to the optimum development of natural resources. The many questions of equity are within the realm of our interests--involving, as they often do, the quality and

distribution of benefits of resource development.

As emphasized above the institutions which surround the water resources are changing rapidly. The Corps economist must be prepared to meet these changes with new concepts and new methods.

VI. How do Division and District Economists Cooperate with the Center for Economic Studies?

We wish to actively cooperate with Districts and Divisions in their economic research needs. Generally, we must undertake research which has wide application and is directed to current planning problems. However, no District or Division should feel hesitant in entering into discussions with IWR concerning specific Division or District research needs. At the present a large part of our research is done under contracts with universities, economic consulting firms or with individual contractors or consultants. We hope to do more in-house research and we have gradually increased this type of work. When Districts and Divisions have expertise in fields of priority we are happy to make research funds available to them, reducing our contract work, and certainly with less risk of inapplicable results. In any case, we are always ready to listen to the problems before the Division and District Economists.

VIII. A Word on the Operation of the General Session.

You will see that we have a very full program. In order to get everything in, the questions addressed to each speaker must be limited. I want to suggest that in the general sessions individuals should not ask questions which can just as well be addressed in the workshops. That is, if you are in the workshop on recreation, you should hold questions on this topic for the workshop, leaving questions in the general session on research to those not in the recreation workshop.

You will note that we have scheduled evening sessions and there will be announcements later in the day on them.

ROBERT W. HARRISON

REMARKS OF JIM TOZZI AT GALVESTON

1. Definition of Economics: The allocation of scarce resources among competing ends.

   In the absence of a specific budget constraint, one could state that the job of the economist is to present information which would permit policy-makers to establish priorities among competing requests for the same limited resources.

2. Question: How many Corps economists work as economists?

3. Duties Performed by Corps Economists:

   A. Criteria for Project Formulation and Evaluation
   B. Criteria for Plan Formulation
   C. Type I Studies

4. Assessment of the Three Above Categories

   A. Criteria for Project Formulation & Evaluation

      These activities have an indirect effect on budgetary allocations.

   B. Plan Formulation

      By plan I mean a group of projects, each of which is assigned a priority. None of this is done in the Corps.

   C. Type I Studies

      Could be very useful in establishing budgetary priorities among geographic areas.

5. Conclusion

   Thus it appears that we as economists are having, at best, only an indirect impact on budgetary decisions. Nonetheless, budgetary decisions are made with or without economists.

   Question raised herein: Should the type of work performed by Corps economists be reoriented so as to have a more direct impact on budgetary decisions?

THE URBAN STUDIES PROGRAM OF THE ARMY CORPS OF ENGINEERS *

The Corps of Engineers public works program has always been responsive to national development priorities. When transport was a critical need, canals and railroads were important ingredients in the public works program. As these needs were satisfied, the program priorities began to focus on the control and regulation of the major river systems. The emergence of an urban society requires that the public works program be reevaluated to meet a changed set of national priorities. Urban problems are now viewed as the major set of problems facing the nation. Therefore, in keeping with its responsive tradition, the Corps of Engineers is reprogramming its resources to meet urban needs. This reorientation or new mission for the Corps will have significant effects on the nature and character of public works program at all levels of government.

In order that the survey program of the Corps be more responsive to the emerging needs of our urban areas, the traditional study program has been broadened to include the following new urban-oriented mission areas:

1. Urban flood control, comprehensive urban site development, flood plain management.
2. Lake and ocean protection and estuarine planning.
3. Regional wastewater and water supply management systems.
4. Renewal of urban river water fronts.

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* This condensed version of the speech by Dr. Sheaffer is based on his paper of the same title.

5. Recreation management (upgrading existing facilities, developing new facilities).

6. Regional harbor development.

7. Model cities.

A reorientation of the Corps of Engineers planning program toward metropolitan water resource management is currently underway. In the Fiscal 1973 budget request, wastewater study for five regions will be broadened to include other urban mission areas outlined above.

The basic reasons for Corps involvement in urban studies are summarized as follows:

1. Urban problems have emerged as having top priorities and the Corps must be responsive to changes in program priorities.

2. Water resource development can effectively serve as an organizing concept for combining private and public resources and integrating all related programs to achieve the synergistic effect.

3. The Corps of Engineers is best suited for the urban studies program because of its past experience in multiple purpose planning.

The reorientation toward urban problems in seven new survey starts for FY 1973 has received favorable response from the Congress and OMB.

John R. Sheaffer

Bill Donovan, OCE

Remarks Prepared for Panel Discussion of WRC's Proposed
Principles and Standards
Conference for Economists of the Corps of Engineers
Galveston, Texas 22-24 March 1972

Unless I miss my guess, the discussion which we propose to initiate in this portion of the agenda should prove as lively and as provocative as any of the topics which are scheduled over the three-day Conference.

My assignment in this session is a fairly straightforward one, namely that of introducing the major topic for discussion, the Water Resources Council's Proposed Principles and Standards for Planning Water and Land Resources. Specifically, I refer to that version of the Principles and Standards as published by the Water Resources Council in the Federal Register on 21 December 1971. And in doing this I also want to call attention to certain provisions of the Rivers and Harbors Act of 1970, namely Sections 122 and 209 which are quite closely or even directly related to the Water Resources Council proposals as substantially revised at the direction of the Office of Management and Budget.

Happily for me, I do not find myself alone in attempting to fulfill this assignment. I am supported by an able and experienced panel of economists and planners widely knowledgeable in the area of water resources policy, planning, and evaluation. These panelists are:

--Dr. Bob Kalter, Professor of Economics, Cornell University.

--Colonel Bob Werner, Assistant Director of Civil Works for Planning and Environmental Programs.

--Dr. Jim Tozzi, Program Planning Group, Office, Secretary of the Army.

--Bob Harrison, Director, Center for Economic Studies, Institute for Water Resources.

We will procede on this basis: When I have finished setting the background for a discussion of the proposed Principles and Standards I will ask each member of the panel to provide us with a brief statement on the subject --formal or informal-- as they deem appropriate. Following this, the session will be thrown open to remarks, comments, and questions from the floor. We trust that topic is of sufficient current and immediate interest to everyone in attendance that it will generate substantial interaction within and among the audience and the participating panel members. However, in anticipating this kind of a discussion and interaction, I think we should all realize in advance that no "final" answers can be provided to many of the questions that may be raised. In this regard, it should be noted that the Water Resources Council is completing public hearings on the new proposals in Washington at the present time. Last week hearings were held in San Francisco and St. Louis. The hearings period is open through the end of this month. Consequently, as the Principles and Standards are only a proposal at this time, we can at best only arrive at tentative and speculative "answers" regarding their final content, endorsement by the President, and time of issuance.

In view of the substantial knowledge and expertise in the subject matter vested in this highly professional audience of planners, researchers, consultants, and academicians, I will provide only minimum --and necessarily incomplete-- commentary on the background of the proposed new procedures. They are descended from the general language contained in Senate Document 97 (29 May 1962),which enunciated broadened criteria for evaluating federal water resource projects. SD 97 itself essentially resulted from

the generally adverse Congressional reaction to the economic efficiency emphasis of BOB's Circular A-47. SD 97 established regional development, environmental quality, and social well-being as appropriate objectives for water resource development, in conjunction with the earlier-stated goal of economic efficiency. However, these broad statements of objectives were not immediately followed by the establishment of procedures whereby they might be employed. This is probably not independent of the fact that OMB has consistently maintained an efficiency-oriented posture with regard to the intrepretation of SD 97.

In 1968 the Water Resources Council, after considerable debate both within and outside the executive branch, announced a change in the criteria on which the discount rate would be selected for use in evaluating federal water projects. The discount rate would be based on the yield rate rather than the coupon rate on outstanding long-term government bonds as provided by SD 97. Congressional reaction to this was quick and direct; it demanded that the executive branch implement without delay that part of the Water Resources Planning Act of 1965 which called for the development of detailed evaluation procedures which would provide expression for the broadened planning objectives set forth in SD 97. This led to creation of the Special Task Force on Evaluation Procedures of the Water Resources Council in November 1968.

Without discussing its work in detail, the efforts of the Task Force resulted in two major docoments: the so-called "Blue Book" of June 1969 and the combined Principles and Standards of August 1970. The "Blue Book" reflected a preliminary effort outlining the basic approach. These preliminary procedures were almost entirely lacking in detail with regard

to the environmental quality and social well-being objectives. These procedures were field-tested by the agencies and a number of independent university field teams. Generally, the results were favorable and many improvements were suggested. Nine public hearings throughout the country also resulted in numerous suggestions toward effecting improvement. (There was also much adverse criticism to the broadened objectives, mostly from those espousing the environmental interest). After issuing its final report and recommendations in August 1970 the Special Task Force disbanded. That is but a brief chronology and suggestive background.

The proposed Principles and Standards, viewed as a further extension of applied welfare economics in the area of water resource planning, are frequently discussed or identified under another rubric, namely that of "multiobjective" planning, an approach, which, as originally conceived and recommended by the Special Task Force encompassed the four objectives of national economic development, environmental quality, social well-being and regional development. It was not a coincidence that these same objectives received the endorsement of Congress in Section 209 of the Rivers and Harbors Act of 1970. Specifically, Section 209 states:

> Sec. 209. It is the intent of Congress that the objective of enhancing regional economic development, the quality of the total environment, including its protection and improvement, the well-being of the people of the United States, and the national economic development are the objectives to be included in federally financed water resource projects, and in the evaluation of benefits and cost attributable thereto, giving due consideration to the most feasible alternative means of accomplishing these objectives.

However, the OMB-revision of 21 December 1971 largely compromises the idea of multiobjective planning. It reduces the originally proposed four

objectives of the Task Force Report to two; these being national economic development and environmental quality. Additionally, where approved in advance, a third objective --regional development-- may be included. However, the approval by whom and under what criterion is not indicated. Thus the current proposals call for two, possibly three, major objectives.

Concommitantly, the new proposals also provide that a system of four accounts be used for displaying beneficial and adverse effects on each of the three objectives, when used, and on social factors for showing and analyzing the tradeoff among alternative plans. In consequence of this, some have referred to the new proposals as a "three-and-a-half" objectives approach, a not inappropriate appelation.

And the discount rate has very much come back into the picture in the current revision. Where the Task Force had recommended that this rate reflect public aspects of the discounting process (social time preference), the rate in the new proposals would be based on the "opportunity cost" of all federal investment activities, a rate computed as approximately 10 percent, although a fixed rate of 7 percent would apply for a period of five years after issuance of the proposals. Among other things, the opportunity concept employed in the revised proposals appears to assume that: investment opportunities occur in an optimal private market economy in which imperfections do not exist, that public and private investments have essentially identical time horizons with regard to the consideration of alternatives, and that the purposes and justification of federal investments are the same as the purposes and justification of private investments. It would be impossible to obtain agreement among a majority of economists regarding the validity of these assumptions.

In order to better understand the significance of the proposed rates, we have recently completed a comparison of benefit-cost ratios using 5 3/8 percent (the current rate applied to project evaluation under the SD 97 formula), 7 percent and 10 percent discount rates for the Corps program classified into four major categories of projects as of 1 January 1972. The summary of this recomputation effort is quite revealing. Briefly, for all of these categories aggregating to a total of 578 projects, 440 are favorable at 5 3/8 percent, 295 are favorable at 7 percent, and only 143 are favorable at 10 percent. However, it is emphasized that these data do not provide a true representation of the economic merit of the projects since the field had neither the time nor the funds to reformulate them or to update and apply more current economic information. The compilation thus represents the niceities of mathematical discounting, no more and no less.

The proposed new Principles and Standards have been the subject of extensive questioning of Corps officers and officials at recent House Appropriations hearings. The line of questioning evidenced much concern with all major areas of the new proposals, including the recommended discount rates, effect on the complexity and timeliness of preparing survey reports, and the plan formulation process itself, among others. The continuing concern of the Congress in this area appears likely.

A significant --and critical-- concern has been expressed as to whether a 1 to 1 ratio in the national economic development objective is a prerequisite to authorization under the new proposals. Some language in the document appears ambiguous and intrepretable on this point. This

was not a requirement in the August 1970 Task Force recommendations, and perhaps it is not a strict requirement of the revised new proposals. However, this may be an academic point if OMB adheres to its policy expressed recently with regard to the Tug Fork project, one of the many projects in the Appalachian Report, the first Corps Report in which projects were both formulated and evaluated within the framework of multiobjective planning. In a letter to the Under Secretary of the Army dated 27 January 1972 the Assistant Director of OMB indicated that the Tug Fork project could not be approved "at this time" because, among other things, "it does not meet the standard test of having a benefit-cost ratio greater than unity." In this particular case, the project had been submitted to OMB with a benefit-cost ratio of .8. Should this prove to be the general case after the new proposals are adopted --assuming that the 7 and 10 percent discount rates remain-- the policy will be severely restrictive on Federally-financed water resource programs.

However, in fairness to OMB, the Congress, and other decision-makers who will be called upon to review projects that may be submitted under the multiobjective approach, the following major difficulty should be identified: Apart from reference to "...an ideally developed system of multiobjective planning in which national priorities and budget constraints..." would be "...integrated with local and regional priorities," neither the original Task Force recommendations of August 1970 nor the revised proposals of 21 December 1971 has provided a concise, unambiguous, practical, interim operating rule by which projects can be rejected while the aforementioned idealized system is developed. Thus, in their present form the new proposals suggest a major problem and dilemma for decison-makers.

While a practical operating rule clearly is needed to abet decision-making regarding the likely value of proposed water resources projects "in the small," an even larger and more significant problem confronts planners independent of whether present or proposed criteria are applied to plan formulation and evaluation. It is this: water resource agencies have been given no real standards to judge their progress "in the large" since with regard to water (but in other major areas, as well) we have no specific set of national goals and priorities that are well defined or agreed upon. But perhaps that is a problem, that merits separate discussion.

Another section of the R&H Act of 1970, namely, Section 122 is not unrelated to the broad concern with multiobjective planning. Briefly, this Section of the Act requires that the Secretary of the Army, acting through the Chief of Engineers, "promulgate guidelines designed to assure that possible adverse economic, social and environmental effects relating to any proposed project have been fully considered in developing such project..." We are working on these guidelines at the present time, preparing them for submission to the Congress by not later than 1 July 1972. The background of the Section 122 requirement would seem to suggest Congress' own concern that all impacts embraced in an Environmental Impact Statement required under the National Environmental Policy Act of 1969 appropriately reflect a balancing and tradeoff that is responsive to economic and social, as well as recognized important biological-physical environmental concerns.

Since this conference of economists has been largely initiated and organized by the Corps Institute for Water Resources, the primary emphasisis understandably on the discussion of research, a discussion reflecting both the need for and the application of research in the ongoing Corps program. My assignment and the assignment of this panel does not relate specifically to research needs and applications as such. However, it would appear to go without saying that the objectives, purposes, and approaches suggested or required by the WRC Proposed Principles and Standards, as well as the requirements and implications of Sections 122 and 209 of the Rivers and Harbors Act of 1970, command the need for a strong and continuing program of p lanning (including the environment) and social studies. Methodologically speaking, their full implementation will take use into deep conceptual and analytical waters. Where heretofore economists have been aware that some of their "economic boxes" have been largely devoid of operable content and theory, the growing multidisciplinary planning approach lends emphasis to the fact that water resources planners are increasingly confronted with an additional set boxes to be filled, namely those marked "social" and "environmental." Consequently, if the multiobjective approach to water resources planning is to be meaningfully applied in practice, then much additional research in support of field applications will be needed in a variety of areas, including externalities, monetary and non-monetary environmental evaluation indices, meaningful measures of social change and indices by which to guage social well-being, systems analysis, urban analyses, improved plan formulation techniques and procedures an improved public participation process to more clearly identify needs and problems,

non-structural alternatives, a clearer perception of regional priorities and project ordering or ranking within these regions, and improvement in evaluation and measurement techniques generally, to mention but a few readily identifiable areas that quickly come to mind.

Thank you for your attention. I'll now call on individual panel members for such comments as they wish to make.

New Procedure for Evaluation of Flood Control Benefits: A Computer Tool for Flood Plain Management

1. Introduction

This is a report on the progress made to date in improving methods for evaluating flood control strategies. Specifically, I want to discuss the status of a computer simulation model for measuring flood control benefits. This model and the concepts underlying it are currently being tested and finalized by INTASA, a private consulting firm specializing in systems analysis. The model has as its immediate objective the quantification of flood control efficiency (NED) benefits. In so doing, the model uses much that is traditional to Corps planning: Flood damage data, and with and without analysis, for example. Several innovations are included - and I will come to these in a moment.

2. Purpose

First a comment on the factors underlying the computer effort is appropriate. In the good old days (if indeed they ever were), the role of the Corps economist in flood control evaluation was simple. All he had to do was assess probable flood damages to existing development and, maybe, add a little for the future. But the concern with broad economic, social and environmental issues which have affected water resource planning in general has encompassed the flood control field as well.

These new dimensions of social concerns already have been highlighted in the opening session of this conference and will undoubtedly continue to be emphasized throughout our deliberations. The net effect is that from this time forward flood control evaluation will become more and more complicated.

Recognizing this factor, OCE, through its Plan Formulation and Evaluation Branch embarked on the above program with INTASA to standardize procedures for evaluation of traditional efficiency (NED) benefits, the main objectives being (1) to more efficiently cope with the increasing complexity of flood control evaluation strategies; (2) to allow analysis of various parameter and uncertain data inputs by bringing to the field the ability to perform sensitivity studies at very low cost; (3) to improve the efficiency of project analysis by using the program as a tool to accomplish reductions in data; and (4) to standardize the presentation of the benefits so as to allow for efficient review and comparison of projects. Obviously these objectives are impossible to obtain without computerizing the complete approach to flood control benefit evaluation.

3. Examples

Let me give you two examples with which you are all familiar and which encompasses a few of the factors mentioned above such as a high degree of uncertainty, lack of data, and the need to perform a number of evaluations by varying assumption, constraints and judgments where planners might reasonably differ in approach.

We all know that we have an increasing number of projects with a high percentage of future benefits. This cannot be over-emphasized. I'm sure this gathering will bear with me while I play with some numbers: For the 19 local protection projects included in the 1970 Omnibus Bill, some 43 percent of benefits, on the average related to existing development, while 57 percent of benefits were associated with future development. This corresponds to an approximate 90 percent existing-10 percent future

ratio for projects authorized in 1941 and an approximate 60 percent existing-40 percent future ratio in 1965.

Another example expressing the need for the computerization is the availability of nonstructural strategies, the importance of which will be highlighted by Messrs. Phippen, Tang and Fredericks in subsequent presentations.

4. These two examples taken together lead to an obvious question: Why commit Federal funds to highly capital intensive flood control measures to protect structures which are not yet in existence and which, presumably, may be kept out of the flood plain or flood proof by appropriate regulatory controls? In one form or another, the Office of the Secretary of the Army and the Office of Management and Budget have asked this question and as a result many of our flood control projects have come under heavy and often justified criticism.

5. Basic Approach

The following basic approach was devised in late 1969 by OCE and INTASA.

(1) First, arrive at a sound understanding of the nature of flood control benefits from an efficiency point of view.

(2) Second, determine the major steps (inputs, parameters and concepts) necessary to understand and assess the effects of flood control strategies.

(3) Third, measure the benefit, adapting the measurement technique most appropriate to the situation.

(4) Fourth, computerize the entire process.

(5) Fifth, utilize the efficiency answers thus obtained as input to total flood plain management plans, including such strategies as regulation,

zoning, flood proofing, information and insurance.

6. Nature of Benefits

Flood control benefits were established as changes in net income, as presented in IWR 70-3, Preliminary Review and Analysis of Flood Control Project Evaluation Procedure, by INTASA. This change in net income represents increased income due to flood protection to both landowners and activities. It was noted that the increase in income may accrue in two basic situations: first, where land use is the same with and without a project and, second, where either a shift in or intensification of land use is induced by a reduction in the flood hazard.

7. It is very basic that in the first situation the "benefits" due to increased land value and activity income are measured by using flood damages reduced. That is, damage reduction is used as a proxy for, or measurement of, all net income changes to activities and landowners. It follows then, that in the second situation other proxies or measures may be available which may prove more reliable than the traditional ones. Two such measures are economic rents and threshold levels.

8. Major Steps

OCE, assisted by INTASA, then turned to the steps necessary to determine the effect of a flood control strategy on net income. The major effect of a flood control program will be upon land utilization. In order to capture the complete benefit, it is necessary to determine the land use in the affected area with and without a given strategy. The INTASA model allocates land use in two stages; a gross allocation which defines areas likely to develop as a unit (subareas) and which specifies the sequence of development among them. Second, there is a detailed allocation

within each subarea where the basic unit is the parcel. Briefly, the following major factors are reflected in the INTASA model.

(1) Policy constraints: for example, open space, zoning, community composition. Policy constraints are inputs to the model.

(2) Economic projections. Obviously a large overall demand for various types of land speaks for higher utilization of the flood plain with and without any project or plan. Economic projections are given to the model.

(3) Flood damages. The higher the flood hazard, the greater the deterrent effect on land utilization. The model utilizes very detailed information on frequency-depth of flooding for different areas of the flood plain (flood zones). Damage depth-value curves, such as those used in flood insurance studies are built into the simulator. The objective is to segregate areas of high damage potential from those of low damage potential.

(4) Locational advantage. The more advantages a specific flood plain has, the more likely that it will be used. The advantage is measured against available alternate flood free areas in the study area. If there are a great number of alternative lands available there is little need to protect vacant flood plain lands; this is reflected in the model. Locational advantages are measured by economic rent, threshold levels and/or a combination of economic rents and land values.

9. I should note that the model can be run assuming any land use that is given to it. In such cases, for example, where the future

land use is inefficient and the residual flood losses are very high, then negative numbers (locational disadvantages) are obtained.

10. Specific Measurement Techniques.

Once land use with and without a plan is determined or given, the model measures the benefit. Where land use is the same with and without, then the benefit is measured by flood damages reduced. Where land use is different, the computer can utilize three alternative techniques to measure the locational advantage:

(1) Sum of economic rents in the study area.

(2) A combination of economic rents and land values in the study area.

(3) Sum of land values in the study area.

10a. The use of economic rent as a measure of locational advantage is an innovation in terms of current Corps practices. This innovation is necessary in order to obtain better answers than the traditional land value approach. Economic rents allow us to better defend the benefit obtained by specifying the source of the net income change. For example, the components of economic-rent differences currently built into the simulator are: differences in transportation costs, on-site development and operation costs, in natural amenities and in socio-environmental factors. In addition, fixed area development costs are utilized where two areas are to be compared, one of which contains basic public services like water and sewers and one of which does not.

11. The conceptual framework of the simulation model is presented in IWR 72-1, "A Computer Simulation Model for Flood Plain Development", "Part 1: Land Use Planning and Benefit Evaluation". This report was

recently published and is available for distribution at this conference. Part II: "Application of the Model to a Case Study" will be finished in June 1972.

12. Using the Computer.

I would like to discuss computerization and flood plain regulation in the context of the current test case, which is being conducted on the Connecticut River Basin in cooperation with the New England Division. I will not burden you now with the details of either the mechanics of the simulator or the specific results on the Connecticut. These will be covered in workshop #5 of this conference on Friday. Dr. Arvanitidis of INTASA will be there to assist me.

13. However, I would like to make three points with respect to the test case, keeping in mind that the whole problem of flood control benefit evaluation arose due to the increasing incidence of future benefits (and attendent uncertainty) and because of the increased complexity of the available strategies.

(1) First, experience on the Connecticut confirms our hope that a computer model can assist us in efficiently directing our study efforts. This is done by sensitivity analysis, where the effect of large uncertainties on benefits can be rapidly assessed and therefore the uncertainty reduced if necessary. Where large ranges of data have little effect on the outcome, further work is not necessary. Hence, the computer not only saves routine computation time but also saves data collection and analysis time by pinpointing those areas which are critical to the analysis at hand. On the Connecticut, for example, it was found that flood damage

potential was the single most critical factor whereas site development costs and amenity values were comparatively insignificant.

(2) Second, the cost of a test run is small enough so that major changes in assumptions, constraints and judgments can be easily reconsidered. A complete run uses about 1 minute of central processing time and 4 minutes of peripheral processing time. The cost is about $20.00 a run. The practical significance of being able to run different sets of assumptions, constraints and judgments so cheaply should not be overlooked. Let us follow, for a moment, the "progress" of a typical high future benefit project through the analysis and review process. The District personnel face the problem of projecting the future. In the face of uncertainty, a best guess is made; other reasonable guesses are available but the planner knows he is unable to pursue these other reasonable possibilities due to time and money constraints. During the evaluation process perhaps some 5 or 10 such critical decisions are made. The report is sent forward for review and OCE and BERH or OSA and OMB questions the District's judgment, pointing to other reasonable assumptions which might have been made. Arguments ensue; the District points out that it is out of study funds; OMB points out that Federal dollars are limited. Finally the report goes back and the District attempts - usually indirectly - to support its original position. (This process may be repeated 3 or 4 times.) Notice how much simpler life becomes when for $20.00 or so, the alternate assumptions can be run - either to be included in the original report or as a later response to a specific review question. In effect, then, the INTASA model enables us to run a

series of reasonable assumptions, constraints and judgments at low cost in order to find out what makes a difference and what does not.

(3) Third, the Connecticut test case was chosen because much of the problem in the area was assumed to be one of devising sound flood plain regulation. The model verifies this assumption and NED, OCE and INTASA are actively pursuing the use of the simulation model as an aid to overall flood plain management. I hope to pursue this matter further in the workshop on flood control.

14. Status

It is the opinion of the Plan Formulation and Evaluation Branch that this 3 year research project is rapidly reaching the point of potential practical applicability. The present test case will be completed at the end of this fiscal year with a complete documentation to follow. It is important to understand that utilization of a computer model of the magnitude and complexity that we are discussing by the field will require additional effort for its full implementation. First and most important it is necessary to obtain field inputs in a process of improving and verifying the model through a close working relation between INTASA and field units on specific projects. Second, all computer programs need upkeep and modification appropriate for specific studies and changing times. In conclusion, the combined effort of Corps personnel in the field and INTASA will be needed to make this extremely useful program a standard tool for us in flood control benefit evaluation.

Thank you.

ED COHN

USE OF INDICATORS AND THEIR APPLICATION IN MAKING PROJECTIONS

(Edmond Schiffers)

For many years, the Corps' project evaluation procedures were limited to considering current needs, and as a result, little consideration was given to the future. Recently, greater attention has been given to developing better estimates of the most probable needs for project functions over the planning period. The issue of future needs spans the full spectrum of different project purposes such as flood control.

In the case of flood control projects, we try to estimate future needs for flood control by recognizing, to the maximum extent possible, the most probable future levels of flood damages which would occur without the project and formulate our flood control project accordingly, giving due consideration to economic growth that may be stimulated by the project. To estimate the future levels of flood damages, the development potential of flood plain lands and potential changes in unit damages should be evaluated.

When we speak of evaluating the development potential we are talking about:

(1) assessing the demand for land to provide sites for the various types of activities, and

(2) evaluating alternative sites for different types of uses, both in and beyond the flood plain.

To recognize the competitive position of the flood plain sites, these evaluations should be made for existing and future conditions for various levels of flood protection. Before the flood plain's competitive position as a supplier of land can be evaluated, the demand for land to satisfy various types of activities expected to occur throughout the project life within the area of influence should be analyzed. The area of influence includes the flood plain plus the area which offers reasonable flood-free alternative sites for those activities which might use the flood plain. The evaluation of land use in the flood plain under different levels of protection (including without project conditions) should be scoped to be responsive to the demand for land as reflected in the assessments of general land-use requirements. When forecasting future land use, projections by property type should reflect the most probable future trends of development in the flood plain for the various degrees of flood protection considered.

Flood damage relationships under existing conditions. - Flood damages include physical damages or losses, emergency costs and business or financial losses. Physical damages sustained by a flood are determined by the number of units of property in the flood plain and the unit damages which are arrived at through an analysis of value-flood characteristic relationships. The property value-flood character relationships for various types of property should be analyzed separately. Flood characteristics include frequency of flooding, direction, water depth and type of debris moved by the flood, etc. For each property category, the property value-flood characteristic relationships should be established independently.

In a study conducted by the Stanford Research Institute [1] to develop data on flood damage to residential, commercial, and industrial properties in California, relationships were found to exist between flood damages and flood depth, market value of structure (without land) and market value of contents. Use of correlation analysis indicated that the greater correlation coefficients were obtained in residential properties than for commercial and industrial, mainly because of the notable diversity in the latter.

For the 248 residential properties which were surveyed in the Stockton area and Elmira, and in the Walnut Creek-Pleasant Hill area, water depth was found to be the most important factor and value of structure the least important of those factors considered. The coefficient of determination was not sufficiently high to encourage wide use in projecting future flood damages without qualification; however, these data can be used to serve as a comparison to test the reasonableness of damage estimates where data on the water depth, the market value of the contents, and the market value of the structure are available.

Another relationship established in the course of the S.R.I. study was that the relative value of the contents has a significant correlation with the value of the residential structure; as the value of the structure (without land) increased, the relative value of the contents declined.

(1) Homan, A. Gerlof, and Bruce Waybur, A Study of Procedures in Estimating Flood Damage to Residential, Commercial, and Industrial Properties in California, Stanford Research Institute.

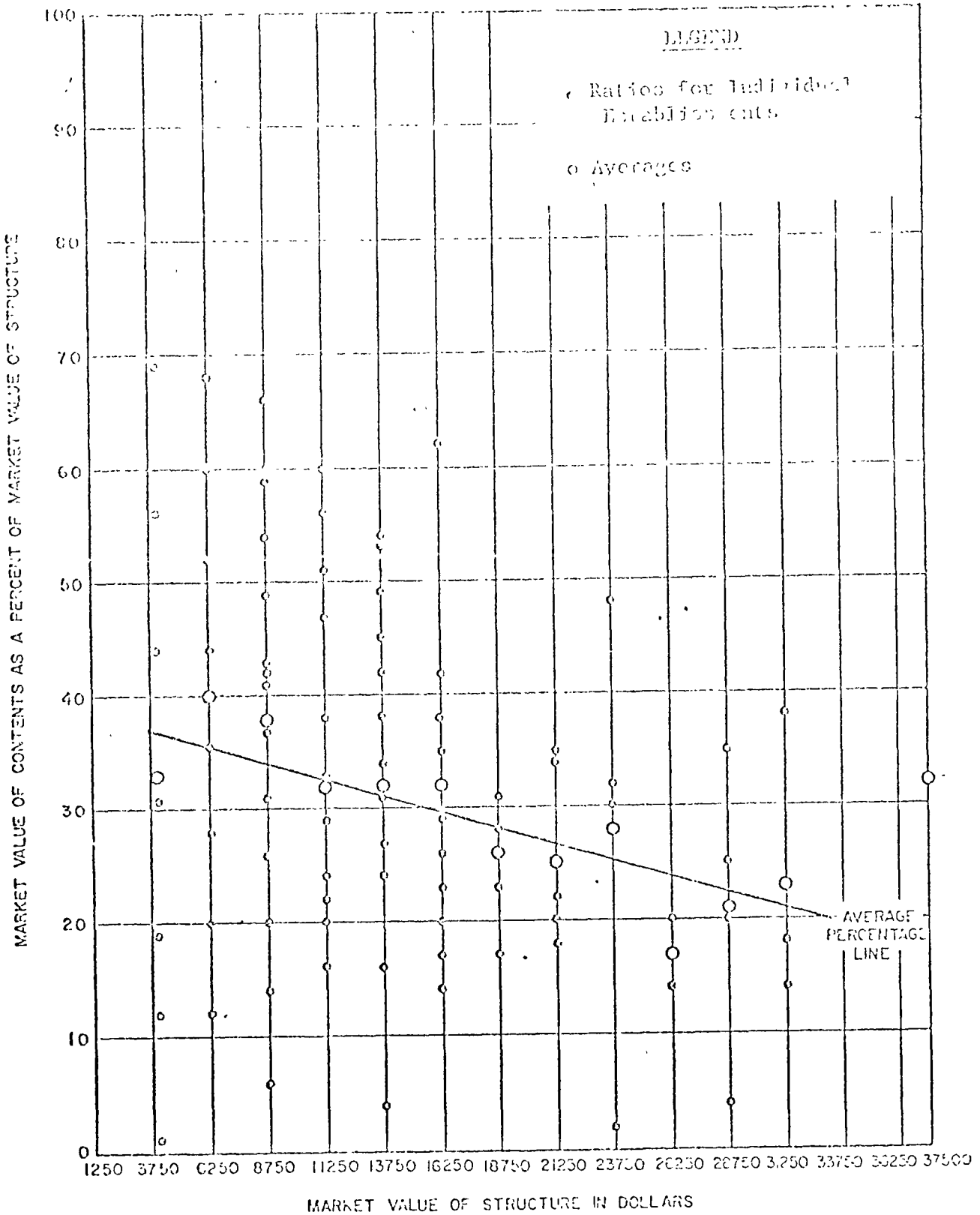
This relationship was tested for structures over a range of from $4,000 to $31,250 in value. For structures averaging $4,000 in value, the value of the contents represented 32 percent of the value of the structures; for structures averaging $32,250, the value of contents amounted to 21 percent of the value of the structure. Figure 1 shows this relationship. Residential contents includes heating units, household appliances, furnishings such as furniture, rugs, pictures, tableware, musical instruments, and personal belongings such as clothing, jewelry, books, etc. A determination of the value of the contents enables flood damage appraisals on contents to be made more precisely. As would be expected, a significant relationship was found between market value of the contents and market value of structure for the residential properties surveyed.

Figure 2 presents a comparison relating dollar damage to contents per $1,000 market value of contents at inside water depths. Additional sampling would perhaps further support a confirming statement of this relationship.

As might be expected, the basic data on flood damage to commercial and industrial properties showed wide variations in depth-damage relationships. Attempts to compare variations in damage ratios with different types of business were not successful. The range in variation of damage ratios within a single business group was usually greater than the range of differences among the various business groups. No consistent trend could be established when comparing the relationships between type of business, inventory characteristics, and similar factors with flood damage at various depths.

FIGURE 1

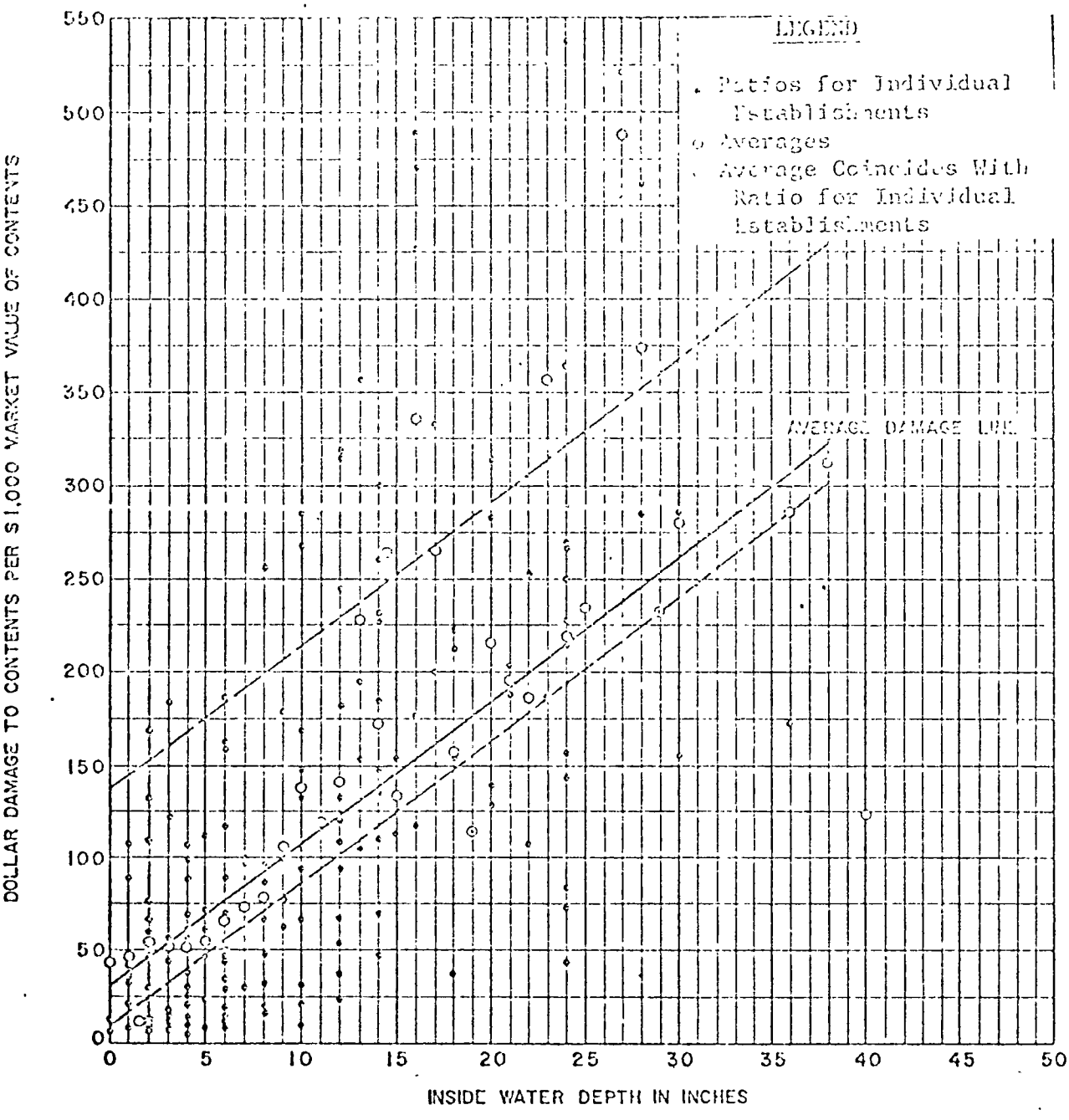
MARKET VALUE OF CONTENTS AS A PERCENT OF MARKET VALUE OF STRUCTURE



Source: A Study of Procedure in Estimating Flood Damage to Residential, Commercial, Industrial Properties in California, by A. G. Homan and Bruce Waybur, Stanford Research Institute.

FIGURE 2

DOLLAR DAMAGE TO CONTENTS PER $1,000 MARKET VALUE OF CONTENTS AT INSIDE WATER DEPTHS



NOTE: Dashed lines (---) enclose two-thirds of all points falling above and below the average damage line.

Source: A Study of Procedure in Estimating Flood Damage to Residential, Commercial, and Industrial Properties in California, by A. G. Homan and Bruce Maybur, Stanford Research Institute.

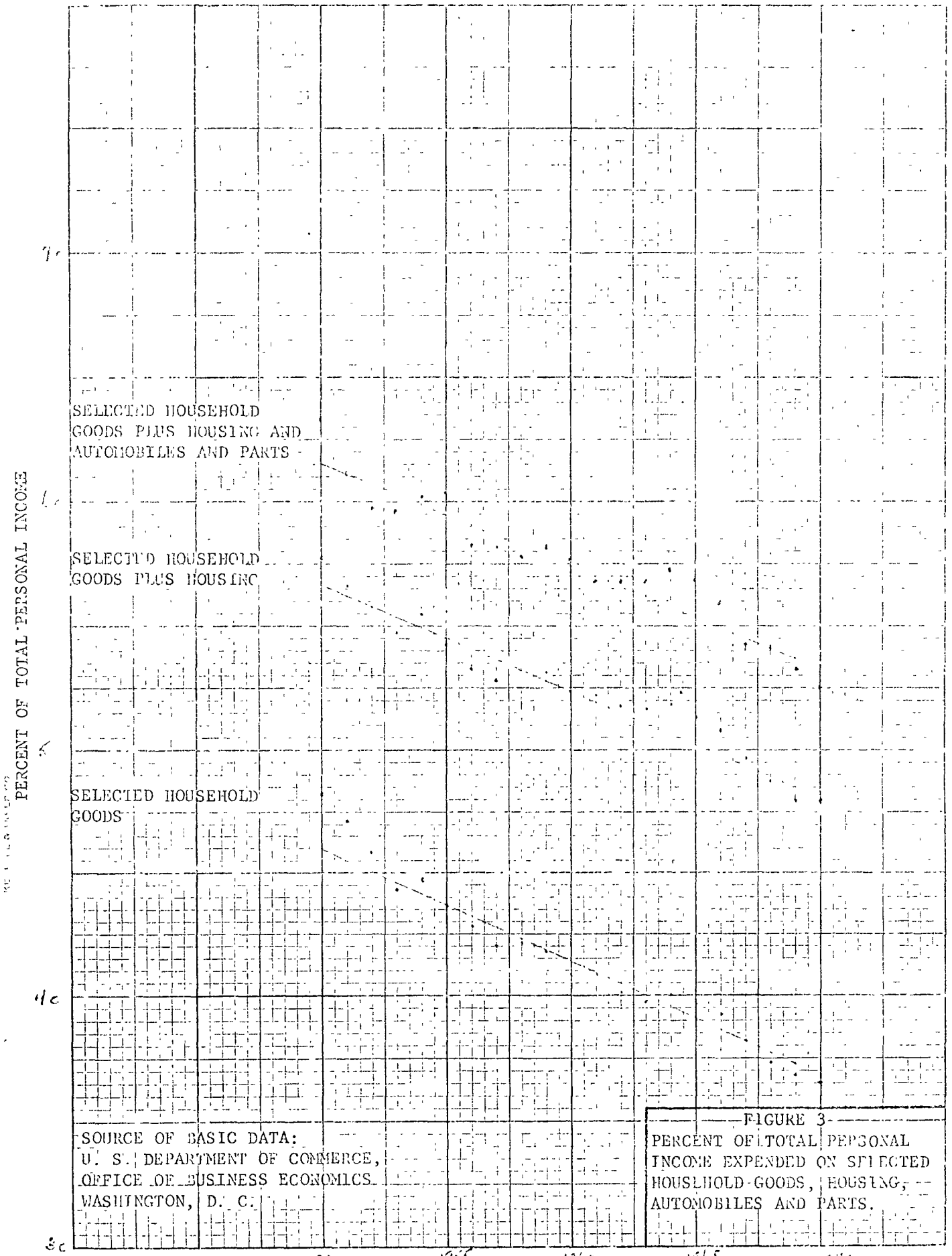
Examination of available information on flood damage relationships under existing conditions emphasized the need for and conduct of good and recent damage surveys as these data provide the base for projection of future conditions.

For several years, there has been a tendency to arbitrarily apply the growth rate of projected income as a damage-expansion indicator to the base-year preventable unit damage values to reflect increases in unit damages over the project life. The rationale for applying this has been somewhat tenuous, being based on the assumption that increases in income will result in similar increases of personal consumption expenditures for goods which would be damaged in the case of flooding. In attempting to examine the propriety of applying income to the residential property category, it was found from the national trends of personal consumption expenditures that the percentage of total personal income spent on selected household goods has been steadily declining. Included in this selected category are furniture and household equipment, other durable goods, food and beverages, clothing and shoes and other nondurable goods. A second comparison of historical data was made combining the percentages of total personal income spent on selected household goods with the percentage spent on housing. This second comparison revealed that the total percentage of income on this combined group has been also declining. A further comparison of historical data covering automobiles and parts, housing and selected household goods indicated that the percent of personal income expended on

this further combined group has also been declining. A graph depicting these historical trends is included as Figure 3. A similar comparison was made relating these groups to personal consumption expenditures. In all three cases, it was indicated that the percent of personal consumption expenditures to these groups declined notably as demonstrated in Figure 4.

This analysis suggests that the appropriateness of applying the growth rate of income should be examined on a project by project basis. It is possible that for certain flood plains projected income might be the most appropriate indicator to apply in reflecting changes in unit damage values; however, for each study the selection and use of income or any other generalized indicators should be supported by demonstrated empirical evidence.

Detailed data on personal consumption expenditures by stratified income level was found to be available on the national level for all urban and rural families and single consumers during 1960-61. This data was obtained from the Department of Labor, Bureau of Labor Statistics. In view of the form in which the data from the Bureau of Labor Statistics was published, it was necessary to combine the selected household goods category with housing. This data is presented below and shows the relationship of expenditures on selected household goods and housing category as a percent of total consumption expenditures.



SOURCE OF BASIC DATA:
U. S. DEPARTMENT OF COMMERCE,
OFFICE OF BUSINESS ECONOMICS,
WASHINGTON, D. C.

FIGURE 3
PERCENT OF TOTAL PERSONAL INCOME EXPENDED ON SELECTED HOUSEHOLD GOODS, HOUSING, AUTOMOBILES AND PARTS.

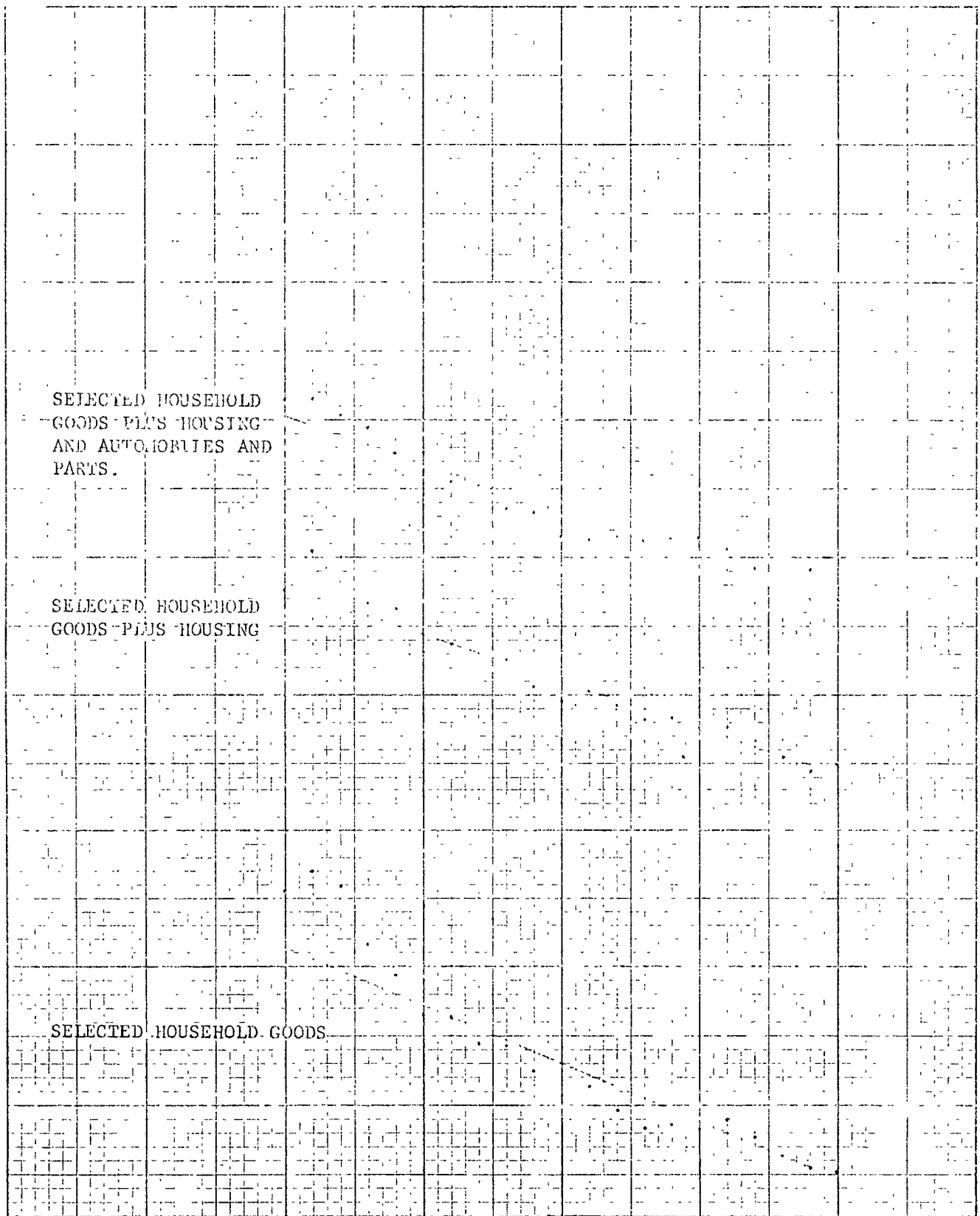


FIGURE 4

SOURCE OF BASIC DATA:
U. S. DEPARTMENT OF COMMERCE,
OFFICE OF BUSINESS ECONOMICS,
WASHINGTON, D. C.

PERCENT OF PERSONAL CONSUMPTION EXPENDITURES DIRECTED TO PURCHASE OF SELECTED HOUSEHOLD GOODS, HOUSING, AUTOMOBILES AND PARTS.

Money income after taxes for all urban and rural families and single consumers in the United States, 1960-61	Percent of expenditures for selected household goods and housing
Under $1,000	69.6
$ 1,000 to $ 1,999	71.8
$ 2,000 to $ 2,999	67.8
$ 3,000 to $ 3,999	63.8
$ 4,000 to $ 4,999	63.4
$ 5,000 to $ 5,999	64.3
$ 6,000 to $ 7,499	63.3
$ 7,500 to $ 9,999	61.9
$10,000 to $14,999	59.9
$15,000 and over	59.1

Several attempts have been made to obtain later data of this type and even data which might have been prepared for earlier years to make a comparative static analysis; however, B.L.S. have advised such data are not available.

The available data indicate that, as income increases, less relative expenditures are made for household goods and housing. This tends to confirm the conclusion drawn from Figures 3 and 4 and demonstrates the fallacy in indiscriminate use of personal income as a gross indicator for projecting flood damages.

Considerable care should be used in the selection and application of damage expansion indicators. The estimates of damages under future conditions are highly sensitive to the application of damage expansion indicators.

This stresses the need to examine the appropriateness of applying income or any other generalized damage-expansion indicator and emphasizes the

possible error in indiscriminate application of any indicator. Selection and application of an indicator should be supported by demonstrated empirical evidence.

Thank you.

FLOOD PLAIN MANAGEMENT: A Challenge to Economists

Flood plain management (FPM) is a continuing program leading to optimal use of flood plains. The Corps role in flood related matters is now to be viewed in this context per ER 1120-2-117. It is part of the overall shifting in planning emphasis from a largely project planning orientation to one of area planning orientation. Economists have an essential role to play in the FPM planning process. One topic, measuring locational advantage, that should be challenging to many economists is suggested here as one of great importance to this process. To put this statement in perspective we first must characterize flood plain management.

The goal in Flood Plain Management is to achieve optimal flood plain use.

The area of direct concern is the flood plain. An area which has been or could be flooded by the overflow from streams (including the channel), lakes, and oceans.

The nature of the concern is a function of: a. the impact on flood plain use of growth pressures from the encompassing territory; b. the impact of floods on flood plain use; and c. the flood plain use impact on the flood plain resource.

Achieving certain objectives provides the avenue for reaching the goal of optimal flood plain use. These have been identified as final outcomes in terms such as economic efficiency or national growth; environmental quality; regional development; and social well being. In FPM context these broad objectives are identified with operational objectives as, for example, flood loss reduction; protection of natural fish and wildlife

habitat and open space preservation; income redistribution; and reduction in the threat to life and health. Achievement of these objectives is governed by a set of basic physical, socio-economic, and planning principles. The thrust of these principles is that the flood plain plays a role as both a spatial and an environmental resource which must be viewed for itself and simultaneously as a part of its larger encompassing territory.

The means of achieving objectives are conceptualized as including:

a. Modification in susceptibility to flood damage.

b. Modification in flooding.

c. Modification in the impact of flood damage on the individual and community.

Embraced are the specific tools and actions such as education; dams, levees and other works; flood plain regulation and floodproofing; development policies; flood warnings; rehabilitations; and the like. These in turn are all predicated on planning.

Multiple purpose and multiple objective planning are essential to flood plain management. Such planning requires a "plan for planning" that sets forth the a) areal frame, b) time frame, c) points of input and review at all levels of interest (local, State, Federal), and d) framework of assumptions. The planning proceeds with: a) determination of the needs for using the flood plain lands by analyzing the requirements of the encompassing territory and the alternative sites available; b) identifying the purposes which flood plain lands are most needed to serve; c) selecting the manner and mode of such use and the most likely means of achieving

objectives with these uses; d) choosing the tools required for these means; e) sorting out the best mix for (1) achieving each objective and (2) achieving an optimum balance of all objectives; and f) allocation of costs to the purposes served.

FPM Program implementation over the long run usually requires actions at all levels (local, State and Federal), but may require only local actions, for example, in the short run. Implementation could be supported on the basis of a prearranged cost sharing by local bond issue or ordinance adoption, State allocation of funds, or Federal appropriations. Involved would be an administrative phase which would continue throughout; usually a land use control (perhaps by acquisition) or regulatory program phase, and often a construction phase which might involve flood modifying works and/or relocations and removals.

The continuing FPM Program would require operation and maintenance of flood control works, periodic plan updating and implementation of plan changes, and drilling on the emergency procedures such as installing dike or window closures and evacuation of people and material among other things. Again the education process would go on throughout this part of the program as it did in the initial planning segment.

Economists play an essential role in the FPM process, particularly in the planning phase. Major points of input by them are the assumed planning framework which often requires growth and income estimates; the identification of needs for flood plain resources including demand for space; and the evaluation of the various proposals in terms of associated benefits and costs.

One area which hasn't been given sufficient attention by Corps and other economists is the cost (also benefits) associated with various measures of flood plain regulation. Some interests allege that these measures have little cost. Others react by implying that the cost of these measures, in terms of opportunities foregone, can be substantial. In the final analysis, the evaluation of these measures deserves the same level of effort given to other flood control measures.

The key issue in evaluating FPM techniques or measures concerns locational advantage. If the flood plain site with its susceptibility to flood damages and related costs have a net advantage for a given use, then a regulation which forces a decision in favor of some lower value open space use would "cost" the amount of the net advantage foregone. A flood control structure to modify the flood may be indicated. On the other hand, if the situation is reversed and the site advantage lies off the flood plain, then regulation should be considered in order to insure that the net advantages or benefits are captured.

Traditionally, the Corps flood control evaluation has been conducted in terms of flood damage reductions. We have little experience in handling the key issue of locational advantages. It is important that Corps economists extend their interest to this area of analysis, particularly at a time when the Corps if moving toward the direction of area planning versus project planning. The work of INTASA and others should help us in this respect although the economists and planners in the field would have to share the burden of making any new evaluation procedures work.

GEORGE R. PHIPPEN

Current Research in Flood Plain Management

I. Introduction

During the past five years the Corps of Engineers has taken several important steps to implement many of the recommendations contained in House Document No. 465 entitled, "A Unified National Program for Managing Flood Losses," (89th Congress, 2d Session, 1966). The Corps has initiated and greatly expanded its flood plain management service program under which flood information and technical assistance on flood damage prevention are made available to interested communities. At the request of the Federal Flood Insurance Administration which was inaugurated as part of the national effort for managing flood losses, the Corps has made studies of potential flood damages for insurance rate determination in many communities. As a policy statement, the Corps issued in 1968 an engineering circular stressing the importance of giving equal emphasis to nonstructural alternatives as to structural protection in flood control investigations conducted by the Corps.

In support of the Corps overall effort in flood control, the Institute for Water Resources initiated a research program focusing on flood plain management. Two studies were completed under this program: one is the community goals management approach to flood plain management by the University of Chicago, and the other is the economic approach to flood plain management by TRW System, Inc. Two studies are underway in the Walla Walla District and in Tucson, Arizona for demonstrating some of the concepts and methods developed for improving flood plain management, including a linear programming approach for land use planning developed by

John C. Day while under the Corps graduate fellowship program in the St. Paul District. In contrast to the studies mentioned above which are concerned mainly with flood plain management in an urban setting, two studies completed by the Economic Research Service of the Department of Agriculture address the problem of flood control benefits in agricultural areas. There is still another related study currently conducted by INTASA of Menlo Park, California, seeking to develop practical procedures for calculating flood control benefits.

All of the IWR studies related to flood control in general and flood plain management in particular are directed toward a coordinated effort seeking better concepts and methods to be used in planning flood control projects. However, each of the studies represents a somewhat different approach and each has different emphasis. The following review will first identify the type of approach associated with the study, then will briefly discuss the significant findings of the study and finally comment on future research needs.

II. Community Planning Approach

The Chicago study entitled, Community Goals-Management Opportunities: An Approach to Flood Plain Management, takes the position that flood plain management in order to be effective must be blended in with other plans and programs of the local community. It views flood plain management as an opportunity to further many of the goals and objectives of the community. The methodology recommended in the study consists of procedures for survey of the physical environment, assessment of community structure, analysis of programs and development trends of the community and determination of the goals and objectives of the community. The

study suggests that Corps planners work closely with local interests in developing flood plain management alternatives that are consistent with local goals and objectives. It stresses the importance of a plan that is acceptable at the local level and can be implemented. It also stresses the importance of integrating flood plain management with other urban programs such as urban development and redevelopment to achieve better results.

The consideration and application of some of the innovative concepts and methods suggested in the University of Chicago study will enable Corps planners to formulate plans and projects more responsive to the need of the people. Although flooding is only one of the problems confronting many urban communities, flood control planners do have an opportunity not only to minimize potential flood damages but to help solve other urban problems as well, such as slum clearance and provision for better recreation facilities. Appropriately, the Chicago report suggests that flood plain management need not stop at issuing technical information concerning flood damage potential but should see to it that such information is being used effectively in community planning. The study's emphasis on Corps involvement in the local planning process involving flood plain use and on the implementation aspect of planning is worth considering by Corps planners.

A serious limitation of the methodology suggested in the Chicago report is that the Corps does not presently possess the authority to get involved in local planning unless such planning has been specifically authorized by the Congress. However, Congressional resolutions have increasingly emphasized the comprehensive and multiple use aspect of planning and the Corps is seeking authorities to undertake studies of urban problems. Under the

present set-up, Corps personnel have little incentive and are even reluctant to take part in community planning which may affect flood plain lands when there is no prospect for building a project.

III. Economic Analysis for Flood Plain Management

The study entitled, A Methodology for Flood Plain Development and Management, prepared by TRW Systems (IWR Report 69-3), represents mainly an economic approach to evaluating the consequences of choosing various flood plain management alternatives. Using the concepts of social willingness to pay and of opportunity cost, the study illustrates how the benefits or costs of various alternatives may be compared and measured. The study also suggests practical procedures for generating a set of flood plain management alternatives and for bringing into the analysis the possibility of alternative developments outside the flood plain. The report does not attempt to develop magic formulas for measuring or quantifying some of the variables which cannot be subject to precise measurement such as the value of open space or the value of saving life. etc., but does provide a broad theoretical framework of a trade-off methodology for assessing the magnitude of the value associated with different choices.

The study includes two demonstration cases in Reno, Nevada and Tucson, Arizona.

IV. Econometric and Mathematical Programming Techniques

With the help of modern computer techniques, it is possible to formulate the flood plain management problem in terms of econometric or mathematical programming models and for achieving optimal (minimal)

cost solution. Dr. John C. Day has done some pioneering work in this respect while a graduate student at the University of Wisconsin under the Corps graduate fellowship program with the St. Paul District. Under a contract with IWR, he is extending his work at the University of Arizona. His work consists of further refining his theoretical framework and applying the model to the Tucson area as a demonstration study.

The basic assumption of Day's model is that a local planning entity would want to maximize the total return (in terms of land rent) from its total land use plan, including the flood plain. The problem is then written as an assignment problem with the maximization of rent as an objective function subject to constraints such as total land area, types and density of uses, and costs of structural and nonstructural protection. and others. Flood control benefits in terms of increased net productivity or rental returns to land can then be derived from the solutions.

One important component of the study is the development and test of an econometric model for estimating the relationship between economic rent and reduction in flood losses brought about by structural flood control measures. Dr. Day is currently making use of the historical sales records compiled by a multiple listing service in Tucson for ascertaining the probable values of rent in alternative locations both within and outside the flood plain.

V. Simulation Analysis

An important current active research effort related to flood control planning is the INTASA study of a simulation model for use in evaluating flood control benefits. The objective of the study is to

develop econometric models or procedures which are theoretically sound yet operationally sufficiently simple for field level application in project evaluations.

The findings of the initial effort by INTASA were published in the report entitled, Preliminary Review and Analysis of Flood Control Project Evaluation Procedures (IWR Report 70-3). Major findings of the report include the following:

1. Where the development in the flood plain will be the same with and without the project, benefits attributable to the project will equal total damages reduced.
2. Where there is project induced growth, the benefits attributable to the project are equal to the net increase in productivity of the economy due to the relocation of activities both inside and outside the flood plain.
3. Benefits from project induced growth (so-called land enhancement benefits) can be measured by the difference between the net income (profits) of activities which move into the flood plain with protection and the net income they could earn outside the flood plain.

The current INTASA effort addresses mainly the measurement problem. The final output is envisioned to be in the form of a procedure or manual for estimating benefits under various assumptions. More on the simulation model will be reported by Ed Cohn of OCE.

VI. Projection Methodology Re-evaluated

Mr. Edmund Schiffers of BERH undertook to re-examine the projection methodology used in evaluating urban flood control benefits. In the Stage

One report entitled, Reanalysis of Projection Methodology to Evaluate Urban Flood Control Benefits (Published May 1971), the author examines the relevance of using an income projection as a proxy indicator to project the values of future damages. After examining the dynamics of flood plain development and evaluating the factors influencing it, the author questions the assumption that increases in income will result in similar increases of personal consumption expenditures for goods which would be damaged by flooding and stresses the importance of a careful selection and application of damage-expansion indicators. The second stage of the research will consist of conducting a stratified survey of a fully developed flood plain in an urban area to learn the primary reasons why those located on flood-prone land selected such sites. The survey will also include questions as to how the residential occupants of the flood plain would spend their income for such purposes as remodeling, expansion, purchase of another residence or for a combination of these purposes.

VII. Miscellaneous Studies Useful for Flood Plain Management

Several recent Corps publications can be very useful as planning tools for flood plain management. These publications are:

1. James D. Evans: An Information System for Improving the Evaluation of Nonmarketed Outputs, IWR Report 71-5.
2. Bruce Bishop: Public Participation in Water Resources Planning, IWR Report 70-7.
3. A series of three reports (IWR Reports 69-4, 71-3 and 71-4) dealing with agricultural flood control benefits and land values prepared

by the Economic Service, Department of Agriculture.

These reports serve to illustrate how regression techniques and linear programming models may be used for agricultural land value analysis and flood damage reduction.

VIII. Future Research Needs

Use of flood plains in disregard of the flood damage potential is a major factor contributing to the steady rise in flood damages. A sound and effective flood control program must consider balancing land use with flood damage potential. A program to encourage and effect wise use of flood plain land is essential in fulfilling the Corps mission in flood control.

While the several studies completed for the Corps suggest many new and useful concepts and methods for improving flood plain management, further research is needed in formulating practical procedures for taking into account the development alternatives outside the flood plain. The conventional B/C analysis is found inadequate for this purpose.

In a recent study entitled "The Flood Plain as a Residential Choice, Resident Attitudes and Perceptions and Their Implications to Flood Plain Management Policy" by L. Douglas James et al at Georgia Institute of Technology, it was found that many people living in the Peachtree Creek flood plain knew of the flood potential before they purchased their properties. They are quite willing to endure floods every few years to enjoy the attractive neighborhood, spacious lots and other amenities of living in the flood plain. The flood events do relatively little damage to properly constructed homes and pose only minor threat to life and health. A policy that automatically prohibits them from occupying the flood plain needs to

be critically reviewed.

Flood plain management can play an important part in rallying the resources of Federal, State and local governments not only for reducing susceptability to flood damages but for enhancing the quality of the social and economic environment as well. Under the present set up, there is no mechanism nor incentive for Corps planners to really consider all alternatives of flood plain management except structural measures. What changes are needed in terms of authority and fundings and also staffing patterns in order that Corps planners may play a more active role in local flood control planning?

It has been suggested that strict adherence in the past to net income gain in B/C analysis for flood control tends to benefit the rich. How is this equity problem to be handled in project evaluation?

Strict adherence to national efficiency objective will preclude many flood control and urban protection projects although such projects may be justified on the ground that they enhance community development. How can community development be articulated and recommended for project purposes so that flood control projects in such depressed communities as Richmond, California; Dyersburg, Tennessee; and Tug Fork, Kentucky may receive consideration?

The Federal Government has taken many important steps in managing the flood losses on a nation-wide scope such as the flood insurance program, the flood plain information service, plus the annual additions to flood control projects in various parts of the country. A timely review of the performance and results of such programs appears in order. James Tang

Water Resources Planning and Regional Development
IWR Expost Project Studies

N. A. Back

The Corps of Engineers has been engaged over almost two centuries, beginning with the first canal improvements in the early 1800's, in major public works that have had important impacts on the growth and development of localities, major regions, and the nation. Yet, over all that time and despite the billions invested, there has been no systematic attempt to analyze and comprehend the economics of public works or to identify and quantify, even roughly, the physical, social and economic effects of the total program or specific improvements.

Formal benefit-cost evaluations were made a part of Corps flood control surveys following the 1936 Flood Control Act to satisfy the statutory condition for Federal participation, namely that benefits to whomsoever they may accrue exceed costs. In the performance of these studies, a considerable body of concepts and techniques has been developed for projecting benefits and costs, essentially on a before and after project basis and at the immediate project level. Little has been done by way of testing empirically the actual results of project operation or how the results compare with the forecasts developed in project authorization studies. Meanwhile, considerable interest had developed in the Bureau of the Budget, the Office of the Secretary of the Army and the Chief of Engineers in having the Corps undertake an expost study of Corps project performance. In 1968 when the Center for Economic Studies was established, the conduct of such a study was high on its list of assigned priorities.

An early attempt at an expost study of several small single purpose Corps harbor improvements and flood control projects by Ralph R. Parsons Co. made clear that considerable work was needed on concepts and methods as a basis for further project studies. Two problems proved especially difficult: implementation of the "with and without project" basis of evaluation and the tracing, identification and measurement or project effects as one of a larger number of elements contributing to the social and economic changes taking place over time and at various levels.

Largely in an attempt to wrestle with these thorny conceptual and methodological problems, the Center for Economic Studies contracted for interrelated studies by Charles Leven and George Tolley, leaders in the application of rigorous quantitative analysis to regional and resource development problems. The results of these studies were published in IWR Report 69-1, Development Benefits of Water Resources Investments, by Charles Leven and Associates, Institute of Urban and Regional Studies, Washington University, St. Louis; and in IWR Report 70-1, Estimation of First Round and Subsequent Income Effects of Water Resources Investment, by George Tolley and Associates, University of Chicago.

Leven's study focused on how changes in output, employment, income and population in one area or region affect the industrial structure, production, income and population in other regions and the nation as a whole--an approach Leven holds is essential in the identification and measurement of secondary benefits of Corps projects. In the preface to the report Leven comments: "the problem to be solved essentially is the same problem for all parts of the country, namely evaluating the national

and interregional consequences of exogenous change in a single region. The solution of that problem, which has been at the center of the bulk of our research effort, requires new theoretical formulations, new analytical techniques, and unconventional kinds and combinations of data. In short, what is needed is not simply a minor revision or extension of present methods of project evaluation, but a whole new way of looking at project analysis for purposes of determining secondary benefits." Understandably, Leven felt that an effort of such magnitude and complexity could best be handled at a central facility rather than at local levels.

Central in Leven's study is the development of an interregional-interindustry model by means of which, given changes as a result of a Corps project in the demand for the products of industry or in industrial cost inputs, it is possible first to identify and quantify the resultant changes in production costs, output and employment in other industries within the region and similarly in related industries in other regions and consequently in the nation as a whole. In effect, the model is an ambitious extension at the interregional level of conventional intra-regional input/output analysis and suffers from its acknowledged shortcomings. Required for implementation of the model are additional heroic assumptions and great masses of hard-to-come-by in-place industrial data.

Despite these shortcomings, one must agree with Leven that given the desire and resources, implementation of the model would have the virtue of providing estimates of total project effects soundly grounded in economic theory and greatly superior to those being estimated by current procedures.

Tolley's companion study concentrates on the conceptual bases and techniques for evaluating direct and secondary project effects in depressed areas, such as Appalachia, and during periods of higher than average structural unemployment, this on the theory that secondary effects tend to be minimal in areas and periods of full employment. The study considers that recreation and industrial water supply are especially efficacious in inducing local employment and income in depressed areas and develops techniques for measuring project benefits from the reduction of structural unemployment, and from higher levels of education resulting from higher income levels in local areas; and presents the results of several studies to test the validity of regional multipliers in measuring secondary income effects.

The studies by Leven and Tolley, even before the reports were published, made significant input into the Corps Appalachian studies and to the studies by the Water Resources Council of revised evaluation principles and standards.

When construction of a Corps project commences, effects radiate out in several directions and dimensions. During the construction period, the influx of workers and income may give the local economy, especially in depressed areas, a strong one-time shot in the arm. To what extent these effects will carry over beyond the construction period will depend on positive timely actions being taken, most of them outside the Corps initiative or control. Contrariwise, in the absence of such actions, the conclusion of construction may witness a serious contraction in employment and income and in the value of non-project capital improvements. Over the longer term, project effects will be determined by the level, extent and

utilization of project services, e.g., flood control, water supply, recreation and barge transport. Viewed primarily in economic terms, these effects may be measured by the difference in the levels of employment, production and income that prevail with the project in being and those that would have prevailed in the absence of the project. Here we are face to face with several difficult problems. To illustrate, what is the appropriate impact area? Clearly the results may be quite different if the area is confined to the immediate counties adjacent to the physical project than if our definition encompasses the state or perhaps the nation, for the larger the area the greater the possibility for offsets and compensatory actions elsewhere in the economy.

One of the projects covered in the Parsons study was a small coastal harbor improvement in Crescent City, California. Direct benefits were primarily the increased fish catch and lower lumber transport costs. Using a modified input/output approach, Parsons computed the total benefits as the resulting increase in employment and income in the local community. Two questions come immediately to mind. What would the computed benefits have been had the area under study embraced a) one or more competing northwest fishing harbors, b) the entire northwest region, and c) the U.S.? The other question concerns the validity of the assumption that the economy of Crescent City would have remained static in the absence of the Corps projects.

With the results of the Leven-Tolley studies in hand, it was decided to once more tackle the task of an empirical expost project evaluation. On completion of the Arkansas River Waterway to Tulsa, Oklahoma, the

Arkansas River multiple purpose project was selected for the study*. The focus of this study differs from that of the earlier studies in several important respects.

a. Since construction of the project was only recently completed, the study will attempt to identify, monitor, and evaluate the project-related changes as they are perceived with the passage of time in the region and elsewhere.

b. Unlike previous studies, to the fullest extent possible the study will encompass the full range of effects--physical, environmental, political, social, as well as economic. It was agreed to conduct the study as a joint venture of the Southwestern Division and the IWR.

To bridge the gap between the earlier studies and the Arkansas study, and to embrace the full range of effects, Charles Leven and a group of associates at St. Louis University were engaged to develop the concepts and approaches specifically appropriate for the Arkansas study. The results of this study are set forth in IWR Report 71-6, A River, A Region and A Research Problem. The foreword to the report provides the following statement of the problem addressed:

> "Expost evaluations are exceedingly difficult, involving problems in selecting proper parameters, determining extent of area to be studied, determining time and timing of observations and isolating what changes would take place 'with' the project from those that would take place 'without' the project. There is little precedent for such evaluations in the water resources field."

Basic to any expost study, the report correctly points out, is the selection of significantly project related indicators of change from

* At a meeting of the Arkansas Basin Development Association on 14 March 1969 Major General Frank J. Clarke, Deputy Chief of Engineers, pledged the Corps to make such a study.

among the almost infinite number of available indicators. For each selected indicator there are three basic data needs and related problems: (1) a set of baseline data representing the total phenomenon prior to advent of the project, (2) related to the first set, gross changes at selected intervals following advent of the project, and (3) data needed in factoring out from the second set of data those changes specifically attributable to the project.

Insofar as economic effects are concerned, the report's major effort addresses the problem of data and techniques needed in factoring out changes attributable to the project. For this purpose, the report by wedding modified input/output and linear programming techniques develops a general equilibrium interindustry-interregional model for identifying changes in employment, output, income and population associated with and growing out of the use of project services. Among the more difficult to obtain data that would be needed in implementing the model are production costs for each proposed affected industry for a number of selected production points within and outside the region, and the importance of transportation cost (in the case of water transport) relative to total production cost as determined by the pattern of market location.

At the risk of oversimplification, three principal steps in the procedures may be identified:

a. Identification and quantification of the total changes (measured from the preceding time base) in production, employment, and income in industries using the project's services.

b. Through the use of interindustry interregional input/output analysis, determine the total regional increase (through all rounds) in production, employment, and income associated with the income identified in industries using project services.

c. Through the use of linear programming, factor out the share of the total increase in production, employment and income attributable to the project.

The procedure employs several heroic assumptions, of which perhaps the most heroic is the assumption that rationality prevails in the distribution of resources among industries, regions and factors of production to the end that costs are minimized and incomes or quasi rents optimized. But before one ventures to tilt at one or all of these assumptions, it behooves him to have a better one to put forth. And who would be so brash as to say that irrationality is to be preferred over rationality as a basis for the analysis of economic action in the large.

The procedures outlined in the report for getting a handle on the sociological and political effects of the project are not nearly as well developed as in the case of the economic effects. This is not surprising considering their less tangible nature and the advanced levels of econometric analysis. However, even in these areas the report points the way to several avenues of approach which give promise of better results than have been possible heretofore.

The Arkansas River Project Impact Study provides the Corps an opportunity to accomplish a task of major importance in public works planning.

It is a task that heretofore has defied successful accomplishment. For example, despite the many claims made for the TVA, there has never been anything approaching a rigorous analysis of its effects. Even today many leading authorities hold that such an analysis is not possible. Perhaps it is a case of fools rushing in. But the Corps is firmly committed to the Arkansas study. My own view is that, although it will not be possible to answer all the open questions, we now know enough to do a worthwhile job which will advance the art of public works planning in the Corps and elsewhere and will bring credit to the Corps leadership in the field. But this will require a commitment over a period of years of considerable funds and personnel, some in the social science disciplines which have heretofore been largely absent from Corps rosters. Undoubtedly, it will be necessary to augment inhouse capability with assistance from universities and other sources. These are available and anxious to participate. I am confident that the Corps will rise to this great challenge and opportunity.

As presently envisioned, a two track approach will be followed in the Arkansas study. Track one comprises the following major components. Development of an econometric model of a multi-regional national economy modified to accommodate non-economic parameters of regional change. The incorporation of non-economic parameters dictates that primary emphasis, especially in the early phases of the study, focus on interrelationships rather than absolute predictive ability. The heart of the research strategy will be to specify and quantify a model; project forward over

a few years, check the projections against unfolding events in the real world; as necessary, recalibrate the model; and, on the basis of the understanding gained in the preceding steps, repeat the projections for the next cycle. Predictive ability as a basis for planning should progressively improve given the improved understanding of underlying forces and relationships inherent in this approach.

The initial approach toward implementation of the analytical system will utilize a combination of a regional input/output model and a model split analysis of the effect on total freight movements and industrial location of the lower transportation charges via the improved waterway. This will be supplemented, if and as necessary, by an industry location model utilizing Leven's regional linear programming technique for projecting the least cost solution for industrial location. In either approach OBERS projections will be used as a starting point. Integration of social, political and economic variables will be attempted through a model of growth center analysis involving factor and discriminant analyses patterned after the pioneering work of Adelman and Morris on the receptivity to foreign aid by underdeveloped nations.*

Additional steps in Track One include analysis of second and subsequent round effects through use of an interregional input/output model; use of a modal split analyses to project waterway traffic; a model for projecting the regional labor supply; and a model for estimating income distribution.

* "A Factor and Discriminant Analysis of the Interrelationship Between Social and Political Variables and Per Capita GNP," Quarterly Journal of Economics, Vol. 79, pp. 555-578; "Performance Criteria for Evaluating Economic Development Potential; and Operational Approach," Quarterly Journal of Economics, Vol. 82, pp. 260-280; "A Quantitative Study of Social and Political Determinants of Fertility," Economic Development and Cultural Change, Vol. 14, pp. 129-157; and Society Politics and Economic Development (Baltimore; The Johns Hopkins Press, 1967).

Track Two of the Arkansas study will concentrate on monitoring and quantifying the project related changes taking place over time and needed in implementing the Track One analysis.

A schematic of the Two track approach in the Arkansas Impact Study is attached.

ARKANSAS RIVER PROJECT IMPACT STUDY

SCHEMATIC

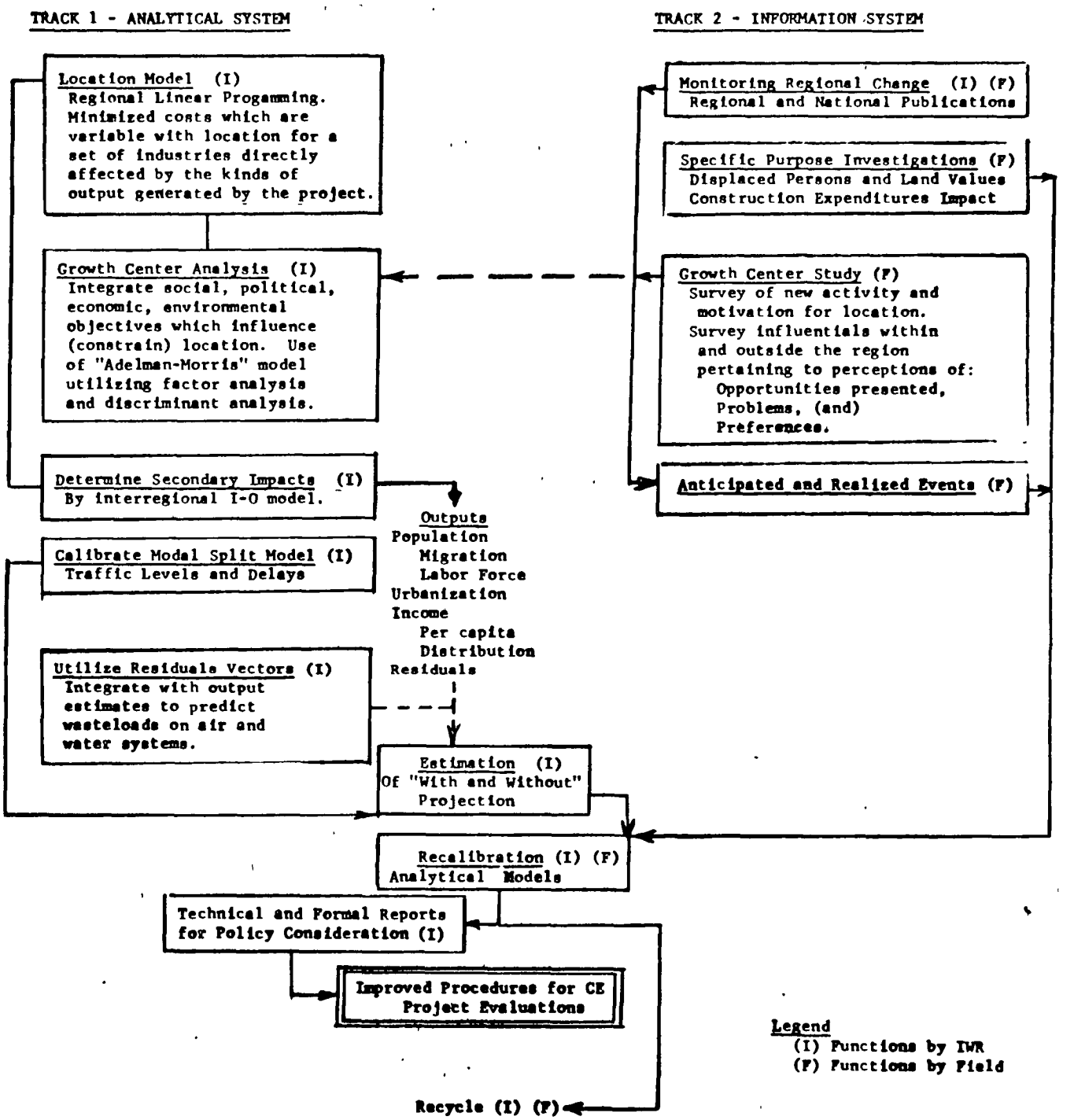


Figure 1
Work Plan
20 May 1971

The Economists Role in Assessing Needs for Water Resource Development

As a matter of general practice, economists have been utilized almost exclusively by the Corps of Engineers field offices in estimating the value of outputs from potential projects and to develop current and future economic base studies of the regions under study.

One of the significant areas for economic analysis for water resources is that of establishing the needs (quantities) for water resource development. Traditionally, engineers have taken economic base studies and projections and converted them into quantity of water needed, acres of flood plain to be developed, etc. Unfortunately, needs have been thought largely in terms of physical requirements or inelastic demands.

Alchian and Allen (1965) discuss the use of needs in this manner as:

> "...a denial of the law of demand.... People often say they need more water. What do they mean? That less than the 'needed' amount would be absolutely intolerable? That even more would be useless? Of course not. Less water (not none) could be tolerated (although less is clearly not desirable).... It is often said that we need more highways. Does this mean we should have them regardless of the cost--i.e., the value of the forsaken alternative? If someone says that 'we need' more teachers, does he mean that, if he had to pay the costs of adding more teachers, he would hire more? Or to put matters in a more transparent form, does he mean that other people should not prefer other things (which they must give up for teachers)? ... When my wife says, 'we need a car' or 'we need a larger house,' if I want to object, I 'agree' by saying, 'of course we need it. What shall we give up to get it? What do we need less."

The Secretary of Health, Education and Welfare, Elliot Richardson, when addressing the problems confronting the agency in formulating their program under a budget constraint (1972) made these cogent comments:

"Choice is the basic reality, and for us it is doubly difficult and saddening because whatever we have to give up is not something bad or trivial, but something that is only somewhat less important, if that, than what we have selected to do.... The President has the most complex and broadest choices to make. He must, within the constraints imposed upon him, select from among the efforts to improve the environment, to improve transportation, to make the nation more secure at home and abroad, to bring sense and humanity to our welfare system and from a host of other worthy and pressing objectives.... The Secretary of HEW must choose among efforts to bring health services into poor neighborhoods, to increase the educational opportunities of children living in the same neighborhoods; to reduce the isolation of the aged, to offer alternatives to delinquency in drugs and among other objectives all of which are worthy and compelling."

"Without ... open discussion of hard choices we must continuously make, the gap between public expectations and government performance will keep growing.... We in government must take a leading role in any effort to restore confidence in government. As a start I believe we must go to whatever lengths are necessary to explain to the American public the necessity for making hard choices among priorities. We must make clear the true cost of worthwhile programs, whoever their sponsor may be...."
(emphasis added)

I have used the two preceding excerpts purposely to shift the emphasis from the problem of estimating water needs to the problem of establishing priorities. They are, however, related problems. Articulating the relationship between goals, priorities and needs and developing workable procedures for integrating them appear to me to be tailor made for economists to make a significant contribution in the Corps of Engineers.

I happened to start working in a District where economists were and are encouraged to participate actively in project formulation, that process of figuring out needs, relevant alternatives and determining the best--hopefully optimal solution. I was also thrust into a similar position while working in the Engineering Branch of the Appalachian Survey. I have spent considerable time during the past year working on a Task Force and Work Group devoted to improving estimates of regional

water resource needs for the Corps PPB System. All of the assignments confronted the issues of needs, priorities and alternatives, but at different levels of concern.

This experience leads me to believe that the PPB System can function effectively at Division and District levels if the process of systematic examination of what we are willing to give up is emphasized over what we or potential beneficiaries want (or call needs). Economists are conversant with this emphasis as being consistent with the basic principle of economics that:

"There is no such thing as a free lunch."

Program Analysis at the District and Division Level

I know of no other information source which is as rich in provacative issues to managers at the District and Division level than that generated in the PPB System. Here is an opportunity to look at the aggregate effects of the current or projected programs. Here is the chance to worry about whether the going program meets perceived needs.

The Corps has been a victim of overemphasis on individual projects. However, the shift of control from the authorization process to the appropriation process has inevitably led to a slackening in the interest in the evaluation procedure, which no longer constitute the limiting factor (if indeed it ever was) to water resource development (Lord, 1971).

The appropriation process is characterized by program submissions and processing, and is closely controlled at OCE, OSA, OMB and Congressional levels. If the Divisions and Districts wish to maintain a viable program, it is incumbent that they develop both the skills and

the desire to pursue a good hard nose analysis which would determine what they are willing to "give up" to achieve more desirable goals. I believe that economists and engineers trained in economic thought can be strategic actors in developing this competence.

Program Analysis at the Corps-wide Level

The Corps has invested considerable time and effort in developing the current PPB System. Divisions play a strategic role in estimating regional needs and the Division Engineer's program recommendations are fundamental to the preparation of the Corps Five Year Construction and Planning Program.

Although the Corps PPB System is the only agency system fully approved by OMB to develop program recommendations, and though the system is utilized continuously by top management, all is not rosy. Mr. Jordan's (Special Assistant to Secretary of Army for Civil Functions) continuous use of the needs presented in the Corps PPB System led to some concern from the Division Engineers. They characterized the needs estimate as "soft" and subject to a good deal of skepticism. Mr. Jordan's response was that the Division Engineers furnished the estimates, so they could harden them. This led to a formation of a Task Force composed of field personnel charged with the objective to evaluate the current "needs" estimates and make recommendations for improvement. A report was made by the Task Force and subsequently a work group was assigned the task for developing guidelines for estimating needs. Proposed guidelines were developed for flood control, water supply and water quality. These were tested at four Districts and the results are under evaluation at OCE.

The Task Force diagnosis of current needs was simply that they failed to quantify the objectives of water resource development. The best example is the objective of national economic development. If we appeal to the law of demand, needs can be arrayed by relative value. The appropriate quantity of water or acres of flood plain needing protection is the equilibrium quantity reflecting the interaction between supply and demand, not the quantity demanded at zero price (which is apparently the usual entry). If we move to multiple objectives, the quantity of water needs under the environmental quality objective will be less than the needs for national economic development. Only special cases of regional development and social well being will tend to increase needs for water development, but to accommodate these objectives would require a simultaneous drawdown in water needs in other regions or for other social classes.

One thing is clear, current notions about needs are diverse, inconsistent and generally ambiguous. These negative attributes filter through to project analysis leading to improper assessment of benefits.

New Directions

Events in and outside the Corps dramatize several issues relating to needs and priorities. The following appear to warrant substantial interest by economists in the Corps and outside:

1) Procedures for deducing demand and supply functions from observed use rates and prices.

2) Criteria for optimizing cost sharing arrangements in relation to needs and their satisfaction.

3) Developing better procedures for assessing needs in the national assessment, agency program analysis, and on types of survey studies.

4) Detecting shifts in preferences and priorities such that needs can accurately reflect the shifts.

Much of the research underway at CES deals with demand estimates. Since the area under the demand curve represents the community's "willingness to pay" and thereby benefits, this work should continue until we gain an understanding of demand elasticity through relevant ranges of demand and the influence of parametric shifts of demand determinants. Additional work in estimating supply functions also appears warranted, especially in those cases where output is generated in both the public and private sectors and by numerous public agencies. For example, recent work by OCE in systematic analysis of inland waterways specifies and estimates the delay component of the water transportation supply schedule, until now omitted from Corps calculations.

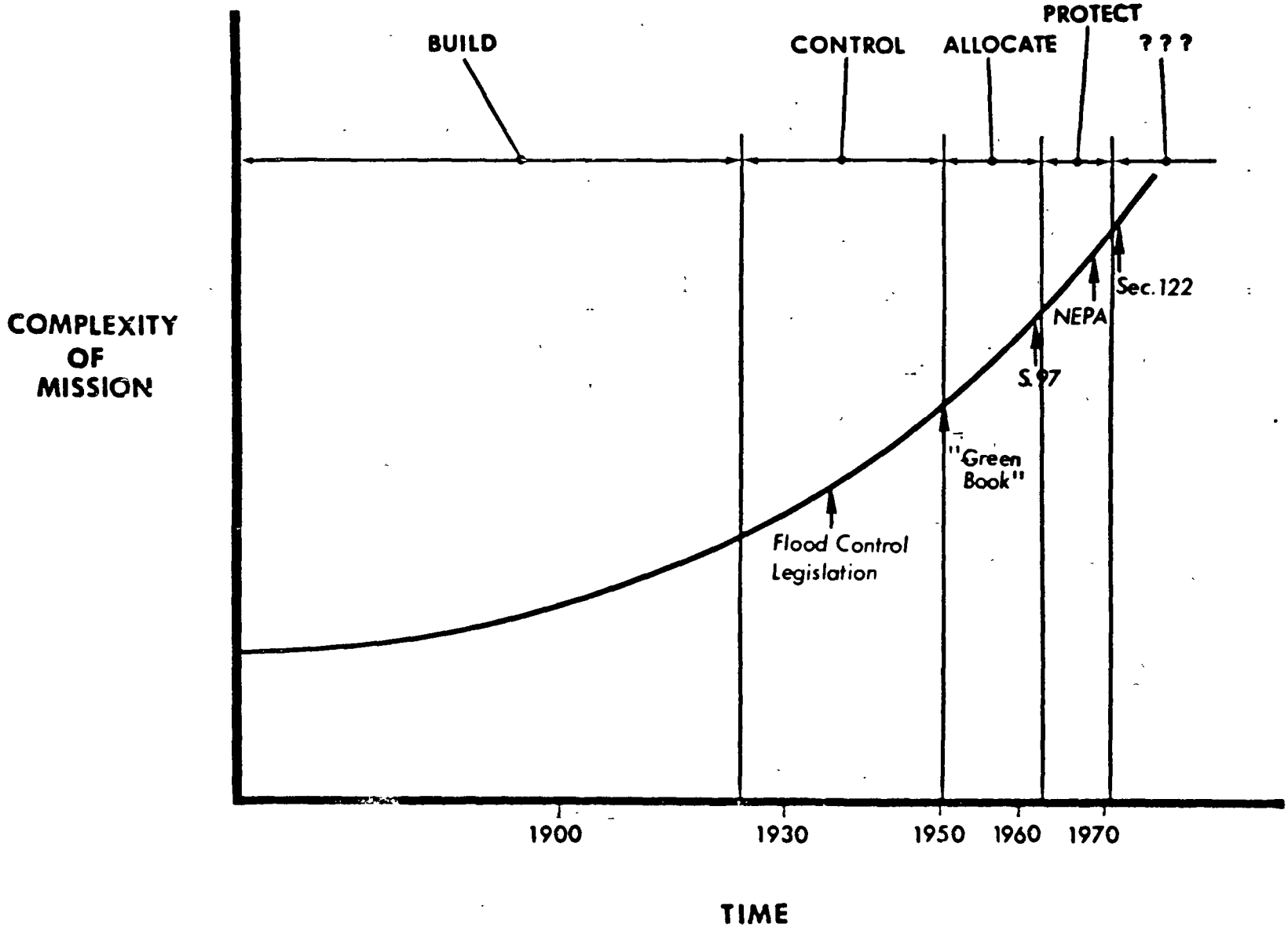
The relation of cost or burden sharing to the attainment of the objectives of water resource development and to needs deserves considerable additional research. Most work to date has concentrated on the disparity between policies which fail to place burdens on beneficiaries and the attainment of maximum national income. If multiple objectives are to be made viable, distributional objectives and the trade off between equity and efficiency must become explicit. Moss, Marglin and Major have articulated optimizing procedures given a cost sharing policy. It seems to me that the question could be turned around to optimize the cost sharing policy and, in a more general sense, to optimize the distribution of burdens (financial, social disruption, environmental, etc.) of resource development.

The activities of the regional needs task force previously mentioned, and currently in the Water Resources Council national assessment are directed towards improved procedures for assessing needs. Obviously, improvement will come only as the understanding and the implication of several crucial assumptions common to water resource planning are perceived. Central to the issue is the articulation of government and agency preferences and weights among objectives.

Rapid change in preferences and priorities are evident. The shifts affect program management and the structure of the bureaucracy. Dr. G. Patrick Johnson of IWR has attempted to portray the thrust of these developments in terms of the increase in complexity of the Corps of Engineers planning. We may argue about the slope of the function, but there are very obvious points to his argument. There is a significant acceleration in the rate of change between "eras," from in excess of 50 years between the building and control phases to less than 10 years between the allocation and environmental phases. Can a large organization adjust to this rate of change? I believe the Institute for Water Resources is uniquely positioned to develop this competence inhouse and then perhaps to develop some recommendations for the Corps overall.

LLOYD G. ANTLE

E R A S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References:

Alchian, Armen A. and William R. Allen, University Economics, (1965), especially pp. 71-73.

Lord, William B. "Prospective Effects of the New Water Resource Evaluation Procedures," The Role of Water Resources in the Economic Development of the Great Plains, Great Plains Agricultural Council Publication No. 54, 1971.

Richardson, Elliot L., "Choice: A Cruel Necessity," Washington Post, 13 Feb 1972.

Robert L. Fulton

WRC National Assessment

In November 1968 the Water Resources Council published its 1st National Assessment report "The Nation's Water Resources." Most of you are familiar with this report, in fact many of you assisted in its preparation.

Work has now been initiated to produce a 2nd assessment. The specific directive for the National Assessment is found in Section 102 of Public Law 89-90, "The Water Resources Planning Act."

"The Council shall--

(a) maintain a continuing study and prepare an assessment biennially, or at such less frequent intervals as the Council may determine, of the adequacy of supplies of water necessary to meet the water requirements in each water resource region in the United States and the national interest therein; and (b) maintain a continuing study of the relation of regional or river basin plans and programs to the requirements of larger regions of the Nation and of the adequacy of administrative and statutory means for the coordination of the water and related land resources policies and programs of the several Federal agencies; it shall appraise the adequacy of existing and proposed policies and programs to meet such requirements; and it shall make recommendations to the President with respect to Federal policies and programs."

Due to the limitations of time at this meeting, and the fact that the procedures for conducting the assessment are still being developed, I

will not attempt to go into details of the program today. I do, however, want to briefly point out what we can expect from the national assessment, how it can be used for planning and the way in which the assessment will be developed.

Organization.

The WRC has established a National Programs and Assessment Committee to assist the Council in developing and administering this program. The Committee is chaired by Harry Steele, Associate Director of WRC. He currently has a systems analyst and economist on his staff to work on the program. Later on he will have additional staff located in the field. Inter-agency work groups and task forces are to be established for the purpose of carrying out various aspects of the assessment.

I serve as Army representative on the Committee. Steve Dola of the Secretary's Office has also been working with the Committee and many others in Civil Works are becoming involved.

New Approaches.

The 1968 assessment has been criticized in that it did not contain the information necessary to make decisions such as those associated with budget priorities, policy issues, research needs, and initiation of planning studies. For this reason the 1975 assessment will be broader and take several approaches different from those used in the 1968 assessments.

This assessment is envisioned to have two major parts, an assessment report and a modern systems approach to provide analytical capability.

The assessment is scheduled to be completed in 1975 with subsequent reports to be produced every 5 years. The analytical system will be a continuing effort. A proposed schedule is attached.

The report will be developed on both a National and Regional basis. The National report will provide tables, charts, etc., showing estimates of water use requirements, estimates of land use requirements and estimates of gross wastewater loads generated at the sub-regional geographic level for the years 1980, 2000, and 2020. The initial analysis will be made using the OBERS projections as a base. Subsequent analysis will utilize alternative projections of population, economic activity and environmental and social factors. Possible policies relating to national and regional growth and environmental and social goals will be reflected in these alternative projections.

Using the National projections as a base, each of the regions will develop similar regional analysis taking into account economic growth and environmental and social constraints from the local regional viewpoint. The regional assessments will be published separately, but will include a brief summary of the place of the region in the national setting. Conversely, a brief summary of these regional assessments along with an analysis of interregional water and land problems will be included in the national report. The two assessments will provide field planners with analysis of local problems as seen by regional interests and at the same time within the context of a national program.

Utilizing the data available for the 1975 assessment, a system is to be developed to provide analytical capability to the Water Resources

Council and member agencies. In contrast to the periodic assessment report, which is essentially descriptive, this portion of the program is designed for continuous use in making decisions. It is to assist in making those decisions associated with planning, implementation, data collection and research activities. It will be designed to provide information and analysis with respect to impacts of changing basic assumptions concerning programming, projections, etc. For example, it will be designed to provide information to answer questions such as; if one half of our annual budget is spent in the South Atlantic Region, what happens to the Lower Colorado Region? If we carry out the Missouri River Plan as developed in the framework study, what effect does this have on various plans for the Mississippi River?

The system is currently in the process of being developed. An agreement has been made between WRC and the Ohio River Basin Commission to test and further develop it this summer and fall on a portion of the Ohio River Basin.

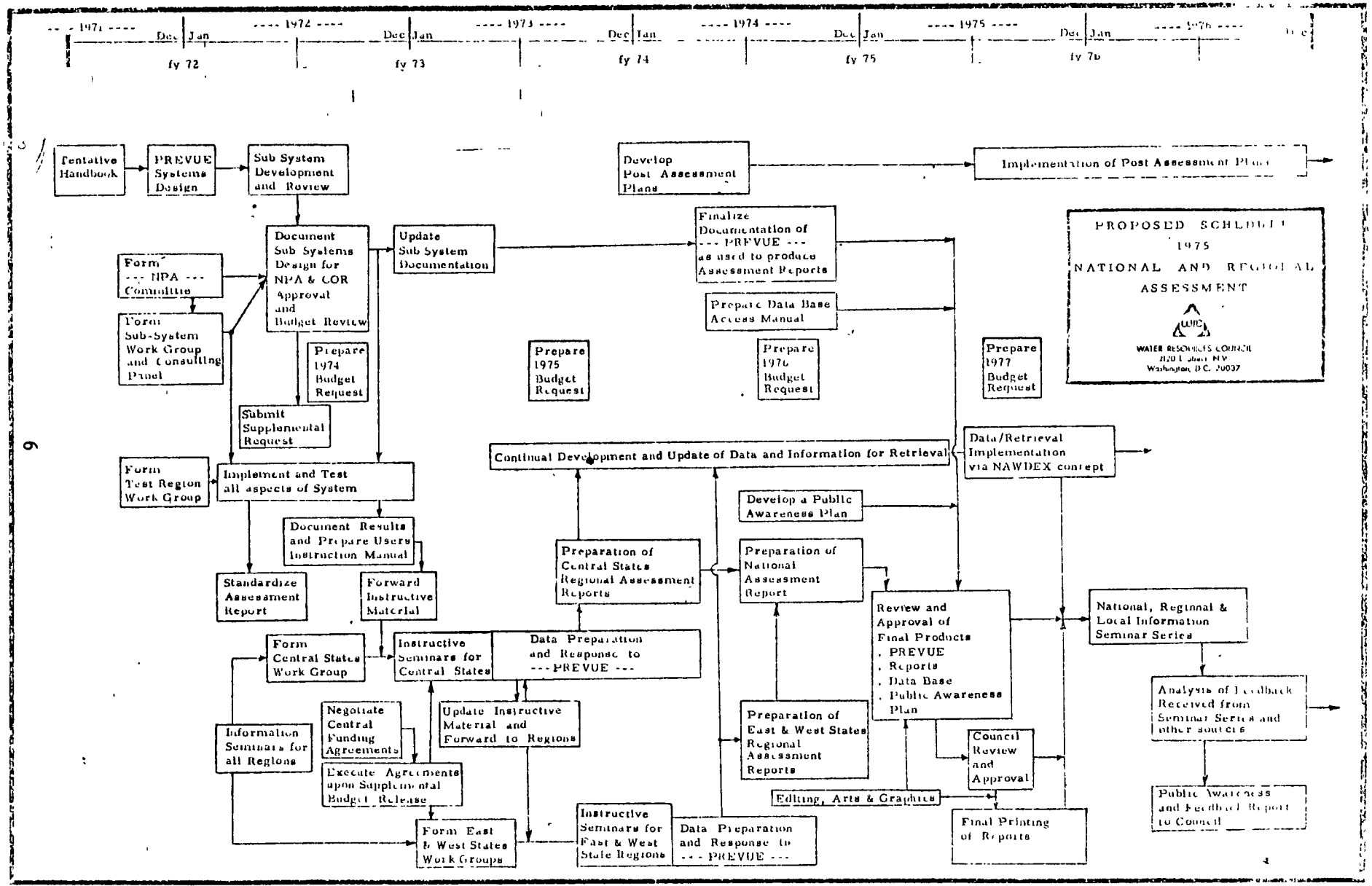
Basic information in the assessment will constitute an updating of essential data from those framework studies now completed or nearing completion. In those regions where a framework study has not been started, a limited planning effort will be made as a part of the assessment. The use of data from different degrees of planning effort will require extreme care to ensure that results of the national assessment analyses are not distorted or biased.

More participation of State-level planning agencies will be required in this assessment to provide inputs to the regional and indirectly

to national assessment publications.

Also, it is important to recognize and allow for the fact that actual regional development potentials may differ from regional estimates produced by the national projection system. These differences are to be indicated and fully discussed in each regional assessment. Also, it may be revealed in the course of assessment preparation that environmental or other constraints within some subregions suggested by the region may preclude or make questionable the meeting of projected requirements derived from the national projections. These constraints are to be fully discussed in regional assessments. Thus, both regional development potentials and constraints may be reflected in regional assessments in terms of more or less economic growth than indicated by the national projection system. The national significance of these regional potentials and constraints will be considered in the national assessment.

Plans call for the regional assessments to be sponsored by River Basin Commissions, Inter-agency Committees and States. The sponsors will be requested to establish special work groups or designate existing work groups to prepare the assessment. I expect many of you will serve on these groups.



AOW 1/5/72

IWR WATER SUPPLY AND WATER QUALITY STUDIES

The Problem

The Corps of Engineers has a major responsibility in the planning for water supplies in the United States. Water supply is provided in Corps reservoirs for both quantity and quality. Stream flow regulation for water quality control is also provided for in Corps planning. The Northeastern United States Water Supply study extended Corps responsibility to plan and construct major reservoirs, major conveyance facilities and major purification facilities. The Corps sells storage rights in its reservoirs to municipalities and to state agencies based on the proportion of the project's cost allocated to water supply storage. In multiple-purpose projects the cost assigned to water supply is limited by estimates of the cost of supplying water from alternative sources, usually a single purpose water supply project.

The Northeastern Water Supply study, the Appalachian Water Resources survey, the Southeast River Basins plan and many other studies indicate that to meet the needs for future water supplies of acceptable quality will require a diversity of approaches, involving regional systems, inter-basin transfers, and probably new pricing and cost sharing policies.

The Corps has not developed a systematic body of knowledge relating to water supply needs. To effectively plan for future supply and quality needs, it is important to know the considerations which influence communities of users in deciding when and how much to invest in water supply for the present and for the future. It has been observed that cities and more recently state agencies frequently purchase water supply

storage in Corps reservoirs greatly in excess of observed need (based on tested methods for estimating future water requirements). This practice is frequently related to community or state opinions on the value of large water supplies in inducing the location of industry. In some cases where industry has not located following large investments for water supplies, communities are likely to default on obligations to pay allocated cost of water supply storage.

The Corps must work with communities of many sizes and types in its water supply program. In the future it will work with an even greater variety of water purchasers. Today little is known about how future needs are determined at the local level and the great multiplicity of local entities complicate the problem of rationally projecting water supply and quality needs. Better information is needed on the quantities and value of water in various uses and the cost of providing better water by alternative means including recycling and reuse. We also need better knowledge of how water availability enters into industrial location decisions and the growth and well-being of regions and the environmental and ecological consequences of alternative water supply solutions.

Better methods are needed for determining the value of water to households and industry. Changes in the demand for water in response to changes in water prices need to be explored as does the relationship between supply and quality. Within the foreseeable future the Corps will be faced with making decisions concerning water supply on the basis of overall regional needs and will not be able to do so on the basis of the first buyer to appear with an agreement to buy water storage.

Published Reports

Cost and Effect of a Water Quality Program for a Small Strip Mining Company (IWR Report 71-7) (Prepared by G. Richard Dreese and Harold L. Bryant)

Environmental quality issues provide a challenge to analysis and subsequent agreement around appropriate public policy. One important perspective to analysis is by means of the assessment of impacts of various alternative policies on a business firm's behavior. The policies can include various levels of environmental control on the operation of a business firm. This case study focused on the impacts on a small strip mine firm in Southeastern Ohio for various water quality criteria on effluent discharged from the firm's mining operations. This requires integration of business operation, market orientation of the firm, the environmental characteristics of current and previous mining operations, the geology and hydrology of the area, and existing environmental law affecting current practices. The report accomplishes a thorough description of these interrelationships and describes a rational course of behavior for the firm under enforcement of various water quality criteria by the State or by Federal agencies (the firm operates in a National Forest). The demand scheduled for coal produced by the firm is estimated, the effects of various water quality measures on the firm's supply schedule are estimated, the relationship of effluent from abandoned mines to current operations are described (untreated effluent from current workings has lower pH than receiving waters), and the peculiar short run marketing environment of the firm (no contract exceeds 30 days) combined to form the basis for several important conclusions.

One, the analytical procedure can produce an estimate of the firm's "willingness to pay" for public or cooperative provision of effluent treatment. Second, the complex relationship between historical and current mining activities on the environment is graphically illustrated. Third, the analysis indicates several feasible solutions to effluent control from the firm's standpoint, if administrative criteria are performance oriented, rather than the application of the uniform technology across the industry. Fourth, the analysis indicates possible adjustments to the firm's output, under various water quality criteria. Fifth, the analysis indicates a strong tendency for further industry concentration if rigorous effluent controls are applied to firms, similar to the one investigated. Thus, the range of impacts from environmental policy is illuminated and a rational basis for policy selection is offered.

The relevance of this analysis to Corps of Engineers program interests lies in the area of estimating benefits and costs from the improvement of water quality. The analytical strategy requires a good deal more information than is normally available to Corps planners, but the basis for choice and recommendation would appear much more defensible than the current basis of ranking costs of alternatives in attaining a given performance standard.

In Preparation

Economic Risk from Water Supply Shortages
(Water Resources Engineers, Inc.)

This research is aimed at improving the Corps capability to plan for adequate supplies of water to meet the growing demands of communities

and industries. The research objective of this project is to define technically adequate means and procedures for estimating probability-loss functions for water supply shortages in urban areas of households and industrial users. The concern is with probable economic losses arising from specific water supply and use situations, and with the kinds of information required to determine the probable aggregate effect of intermittent water shortage over a broad area covering typical urban conditions and water distribution systems. The study will appraise the various methods and procedures for analyzing economic losses from water shortage.

The Integration of Surface and Ground Water Use in the Appalachian States (Pennsylvania State University)

There are a number of areas in the Eastern United States where water supply planning should include a greater emphasis on the use of ground water resources. This research project is directed at the planning requirements where joint use of ground and surface water supplies is required to efficiently serve the water resource needs. In the perspective of diminishing construction sites for surface reservoirs and the possible advantages of dual systems in times of drouth, it seems warranted to take a fresh look at the economic, hydrologic, and geologic aspects of water resource management in humid regions where there is a potential for the integration of surface and ground water supplies.

Interregional Planning of Water Resources Allocation: A Systems Analysis Approach

Growth in the demand for water and changes in the technology (and cost) of transporting water make it necessary to consider the impact of water resource plans over wide geographic regions and over longer time periods than has been done in most past projects, or in present efforts.

If projected levels of water use are to be realized, projects on a scale not attempted in the past may be required in many regions; in a few instances such projects are now being planned and constructed. The evaluation of these efforts requires a new and closer appreciation of the chain of alternatives involved. While alternative developments have been considered, little attempt has been made to evaluate the alternatives in a manner which would account for the interrelationship (including interdependencies and externalities) among the various geographic and economic sectors which compete for water use in an entire region. Methods and techniques are required that will make possible an explanation of all principal consequences of alternative plans and developments. Thus, the objective of the proposed research is the development and application (to the State of Utah) of a methodology for planning the temporal and spatial allocation of water and water-related resources.

The development and testing of an engineering-economic system analysis shaped to the field of water resource management is sought. This will require the introduction of mathematical programming and input-output techniques to water resource analysis and planning on a scale not attempted before. It is expected that this work will build on the extensive exploration that has been made of regional economics employing input-output and/or general programming models.

The Study of the Treatment of Water Quality Factors in Water Supply Analysis

Much of the research in water supply has sidestepped the quality issue by either assuming constant quality requirements in all cases or assuming quality away from the analysis. Either approach precludes the necessity for costing out ways of changing the volume of water of given quality by use of pollution control methods and equipment.

The research objective is to provide engineers and planners with needed guidance for including water quality considerations in water supply/demand analysis and in functional resource allocation analysis. This research would also allow consideration of factors which may reduce quality and hence reduce effective supply.

Study of Industrial Water Use Consumption, by the National Bureau of Economic Research

This research is an effort to develop a methodology for anticipating consumption rates of industries using large amounts of water as the availability, cost and quality of intake water and effluent standards are altered. The research team is composed of an engineer and an economist with a view towards identifying developing technology of various industrial processes which affect water use. It is anticipated that rational response by industrial firms to be both adjustments in production and alteration of technological use of process and cooling water. The adjustments have both spatial and temporal dimensions, and are not expected to be homogenous across all firms, time or space.

Conclusions from this research should be directly applicable to the estimation of future water use in river basin, wastewater management and project studies in the Corps of Engineers.

ROBERT W. HARRISON

ANALYTICAL SYSTEMS FOR NAVIGATION

Introduction

All who labor in the field of resource development are constantly bombarded with requests for rapid answers considering new alternatives to accommodate changing priorities, revised guidelines, emerging technologies and the morning's hottest letter or most unintelligible post card. This is in addition to the needs for survey reports, framework investigations, design memoranda, reconnaissance reports, feasibility studies, national assessments, PPBS statements and just plain Dear John and Dear Mabel letters. The engineering fraternity can recall the good old days before the economist who in turn is starting to recall the good old days before the environmentalist and the multi-objectivist.

To aid in answering the questions regarding the economics of planning for navigation, the beginning of several systems of organized information and analysis have been, are being and will be developed on a national or

inter-division basis to assist the harassed water resource planner. This paper will address briefly the start of an analytical system to incorporate all forms of waterborne transportation on a nation-wide basis. Other papers in this series will discuss systems analysis for inland waterways, deep-port development and the application of the statistical tool of discriminant analysis to transport mode determination.

Analytical System for Evaluation of Navigation Improvements

Awaiting solution is the problem of developing an analytical system on a nation-wide basis for the evaluation of navigation improvements. A computerized system is needed to provide the means to (1) evaluate multi-port systems; (2) incorporate all relevant factors on a systematic basis; (3) test a wide variety of alternatives; (4) provide a rapid update of plans based on new information, new technologies, new policies, changes in priorities, changes in magnitude and location of commodity demand and supply and changes in transport demand and supply.

A start on developing a methodological approach to his problem was made by the Transportation and Traffic Safety Center of Pennsylvania University under contract with IWR. The Transportation Center, under the direction of Dr. Joseph L. Carroll, has prepared a draft of a state-of-the-art report for IWR, regarding the methodologies available and recommended. The next step will be to determine the data needs for the analytical system. An IWR Seminar was held in January 1972 and a published report is anticipated during 1972. An annotated bibliography and a computerized bibliographic index have been developed in the study effort and will be included in the published report.

The analytical system will be based on the major trades including petroleum, ores, grain, coal, general cargo and other commodities as required. A simulation model will be developed for each trade for U.S.-overseas traffic, and U.S.-U.S. coastwise traffic. This will include U.S. Great Lakes traffic and the interface of ocean and Great Lakes traffic with the inland waterway traffic.

The basic ingredients of the analytical system are the origins and destinations of the commodity flow, ports used and mode of inland transport. The system will include the transportation costs for the water and land modes and transfer costs if significant. Also, the system will incorporate projections of commodity flows. The questions that can be asked of the system include:

a. What is the result if Port A is improved to handle larger ships and Port B is not?

b. What are the changes in commodity flows and harbor and channel requirements if the foreign origins of imports are substantially changed?

c. What are the alternative ports and routings required to serve U.S. interior points based on alternatives necessitated by environmental considerations, new industrial centers, new ports, new towns or other factors?

The analytical system will encompass the deep draft shipping as well as all the types of ocean shipping calling at U.S. harbors. The application of the system will present for the first time on a national scale a computerized method to evaluate many alternatives in a rapid manner.

Further actions of developing and calibrating the needed models will be undertaken as fast as possible. The foreign trade commodity flow

study currently underway will provide information on general cargo and will be one of the first trades to be in the analytical system. Data regarding bulk commodities will be included in the next phase of the analytical system. The deep water port studies underway by IWR will provide some of the required data on bulk commodities.

Foreign Trade General Cargo Commodity Flow Study

The general cargo commodity flow data regarding U.S. foreign trade required for the analytical system and current Corps planning are not available from any existing program. To overcome part of this problem, IWR and the North Central Division on behalf of the Buffalo District of the Corps along with the U.S. Department of Transportation are jointly sponsoring a commodity flow study by the Bureau of Census. This study will develop data on a nation-wide basis for about 42,000 foreign trade transactions for imports and exports by vessel (30,000) and air (12,000) of liner-type general cargo commodities. The 42,000 transactions are a stratified sample of the 1970 foreign trade. The unexpanded sample of the waterborne commerce represents 64 percent of the exports and 45 percent of the imports of the foreign trade universe. Census foreign trade data regarding the international segment of each movement such as commodity weight and value, foreign area and international mode will be supplemented by responses from questionnaires to shippers regarding the domestic segment of each shipment. That domestic segment data will include the location of the origin or destination of the export or import, respectively, the mode of transport and the distance of haul. The questionnaires request information regarding the type of containerization or packaging for both the international and domestic segments of each shipment.

The data will be used for several Corps studies including those for the Great Lakes-St. Lawrence River navigation system, the San Francisco Bay study, and other coastal port studies. In addition the data will be used in research efforts to calibrate the foreign trade flow model of the analytical system and in other IWR research studies.

The data collection phase has been completed and the analytical phase is underway. A public report and public use magnetic tape will be prepared for release by mid-1972. Presently available is a publication titled, Status Report and Plans for the Survey as of October 1971, part of the study of Domestic and International Transportation of U.S. Foreign Trade: 1970.

Interface of Barge and Other Modes of Transportation

Preliminary discussions have been held for a joint research study sponsored by IWR and the Department of Transportation regarding the existing problems and the potential of additional coordinated movements of barge with other modes of transport. This research would include the analysis of the impediments to coordinated hauls by barge and other modes and an estimate of the potential of coordinated barge movements to determine potential traffic for Corps locks and channels. This study will complement the already well developed inland waterway simulation model that will be discussed later in this program and will be part of the overall analytical system for navigation. The study will aid in ascertaining the full potential of barge traffic as another input for the system analysis for inland waterway discussed in EC 1120-2-71, 7 January 1972.

Howard E. Olson

SYSTEMS ANALYSIS FOR INLAND WATERWAYS

(William J. Rhodes & Russell K. Adams)

In a group as large as this it is understandable that there would exist a large range of knowledge about systems analysis. Some of you know a good deal about the subject, some have a reasonable acquaintance with the subject, and some, like myself, can hardly pronounce the term without stuttering. I think it wise, therefore, that we take a few moments to define our subject so that we can all start out on a fairly equal plain.

To put it in the simplest of terms, systems analysis is a means of determining the way to get the "most bang for your buck." In economic jargon, systems analysis is defined as "an explicit quantitative analysis designed to maximize the value of a particular objective function after deducting the value of resources used." I like my definition much better.

Okay, now that we know what it is, so what? Why do we need systems analysis to study our inland waterways?

In the past, our planning, construction, and operations of our inland waterways have been predicated on an individual project basis without serious consideration being given to the relationship of the individual project to the overall system of interrelated projects. In other words, if we were planning to replace a lock in the middle of the Ohio River system, we focused our study on that particular lock and didn't give much thought about the locks immediately upstream or downstream. The net result could very

well have been the transferring of congestion from the lock being improved to an adjacent lock. Likewise if we were planning the navigational improvement of a new waterway, we didn't consider the effect that the newly generated traffic would have on existing waterways over which the new traffic would have to move. Take the Red River for example. If we improve the Red River by the addition of locks and dams so that commodities can move by barge to and from Shreveport, Louisiana, the same barges will also be moving on the Mississippi River system and the Gulf Intracoastal Waterway. Thus, an improvement on the Red River could have a profound effect on the existing portions of the inland waterways. Previously we have not been taking these external effects into consideration, that is, we did not adjust either the benefits or the costs for the Red River to take into consideration the extra burden that was being imposed on the rest of the system.

About five years ago, the Bureau of the Budget, now the Office of Management and Budget, began asking embarrassing questions about our inland waterway program. Due to some rather severe budgetary restrictions they wanted to know why we wanted to improve lock "x" instead of lock "z" and what future costs would be generated for the rest of the system if we improved lock "x". We were embarrassed because we didn't have the right answers and started looking in new directions to get the appropriate answers.

With respect to new directions let me first describe to you what we have been doing in the area of applying systems analysis approaches to our

inland waterway problems. Essentially systems analysis involves the technique of looking at or analyzing the waterway system of each subsystem as a whole, as opposed to analyzing single projects in isolation and ignoring their effects on other parts of the system. Systems analysis, using various techniques, including simulation modeling, will permit the examination of alternative courses of action in terms of effectiveness and cost, not necessarily in dollar terms, to help clarify the relevant choices and their implications. This type of analytical process attempts to describe and estimate the cause and effect relationships of underlying factors in an operation of a total inland waterway system environment. However, the primary purpose of these evaluations is to provide the decision makers with sound, scientific and quantitative bases to make decisions. The use of systems analysis is especially important and advantageous in that it attempts to place most all factors in proper perspective and through various techniques, including simulation modeling, it permits "experimentation" on paper, without manipulation of the actual system. We hope this type of analytical capability will improve management decisions on timing and scheduling each replacement, developing a lock modernizations program, and provide a basis for more efficient operation and maintenance of the existing system. The end result of a system analysis should result in the formulation of plans which include the time, location, and types of improvements that will ensure better management, operation and maintenance of the entire system. This in essence will then be a master plan for the orderly development and the most efficient operation and maintenance of the total inland waterway system.

While the major thrust of the current Corps' effort is the development of a total systems analysis, for operation, maintenance, and further improvement of the inland waterways, and eventually our total navigation program, it must be borne in mind that extensive development of analytical techniques will be required. During the intervening period operations for the navigation system will continue on the same basis unless interim guidance is provided, and therefore, the results will fall short of any manner of a systems approach. Present efforts are being concentrated in refining the simulation techniques for use in modeling the inland waterway systems.

Until we are able to develop a complete systems analysis methodology for the inland waterway system, the simulation model recently completed by Dr. Joe Carroll, of Penn State for the Illinois-Upper Mississippi-Ohio River system offers the most immediate payout and has therefore, been adopted by the Corps to simulate inland waterway operations. This model is now operational at Penn State and the Waterways Experiment Station and can be used with computer hardware available at most District and Division offices. This model provides output on physical waterway operations in the form of total time of delays, length of queues at locks, and identification of delay points. Data required for inputs to the model can be collected with some effort. Field offices should therefore utilize the simulation model and apply it to as large a subsystem as data permits. Caution should be exercised not to rely on the simulation model for investment decisions.

The simulation model will provide only partial information needed for such decisions. It will identify traffic bottlenecks and quantify potential delays to waterway traffic, and by making several runs using many variables, it will determine the sensitivity of certain variables, and will suggest structural or non-structural changes to improve system efficiency. In our workshops on inland waterways we will be able to examine print-outs of various runs using the Carroll model. However, it will not evaluate the benefits and costs for system changes. A more sophisticated and complex model of a different type is required for this. It should be pointed out that the simulation model requires inputs of predicted origins and destinations of future traffic flows, the determination of which is the subject of quite detailed demand and modal split studies. A resource allocation model will be required to evaluate the benefits and costs of a proposed system change. Such a model will, of necessity, be a multi-mode transportation model. A seminar on the existing mathematical simulation modeling is being held on 28-30 March by the Waterways Experiment Station in Vicksburg under the sponsorship of OCE. All Divisions and Districts have been invited to participate in the seminar wherein they will be furnished the background and future capability of the existing model and how it can be used in their studies.

Systems analysis is vital to our planning effort in determining the location, size, and sequence of construction for additions or improvements to our inland waterway system. However, a very important point about systems analysis is that it can be helpful in instituting an operational

improvement program which will extend the useful life of existing facilities without major construction. Let me state at this point that many of these items involve all of Civil Works and are not unique only to planning or the economic area.

The Corps is now actively pursuing a systems analysis review of its inland waterways projects as a logical sequence to its continuing efforts to improve project efficiency, to reduce operating costs, and to permit deferral, as long as practicable of further capital investments for improvements.

As one facet of this analysis and clearly indicative of new directions, we have tested the possible use of tugs to assist the passage of multiple lockage tows at the locks. This was done at Lock and Dam 26 for a short period last year at Federal expense. It has also been used on occasion at locks on the Ohio River during periods of partial outages, and has been the practical result of the absence of tie-off facilities in the New Orleans area, the added lockage effort in this instance being at industry expense. We now propose to continue this practice at those locks where significant benefits would ensue.

We've been working with industry in these areas and have been involved in a real "Donneybrook" as to who will pay for the switchboats. OM&B has established a policy that it will not be the government, and there is real disagreement among the various industry groups.

The OCE proposes to consider a procedure, possibly for the lock operator to require switchboats for multiple lockages, as an initial effort for Lock

and Dam 26 on the Mississippi River and consideration for eventual use at Brandon Roads Lock and Dam on the Illinois River. These two projects were selected as the ones at which immediate benefits could be achieved. As river traffic becomes more congested at other locks, we would expect the practice to be extended to them. Industry will be expected to bear the cost of the switchboats.

Additional actions both of a regulatory nature and others will be considered and undertaken as appropriate. For instance the practice of locking 3 up and then 3 down will be expanded to other locks when and where practical. Considerations are being given to increase staffing at busy locks to have an operator at all controls during the heaviest traffic periods. A need exists to centralize and automate controls to trade automation cost for staffing and to utilize the best visual and voice communications available. Investigations are being made for provisions of tie-up cells, approach walls, and debris protection. Our field commands are well aware of the need to examine every facet of their operations for possible improvements. We have visited the Welland Canal in Canada to view first hand the traffic control and regulation that has been so successful on that waterway. We will be looking closely at those controls to determine the practicality for use in inland waterways. As we examine these many facets of the problem it is also our intention to keep our lines of communication open to the field offices to utilize your help in all these areas. In fact we expect the local Corps' offices to be instrumental in initiating innovative changes since you in the

Districts and Divisions have much more knowledge of the local situation than the Washington level can ever hope to have.

In the past, it has generally been assumed that the obstacle to more efficient water transport is inadequately sized locks. While much attention has been given to lock enlargements, little has been done to look elsewhere for improvements. Recent experiment programs at certain locks, and actual changes in operating procedures at others, have proven the value of intensive examination of locking procedures to improve waterway efficiency. Additional studies should be made of (1) locking operations to reduce service time, (2) towing equipment modifications, and (3) other changes extraneous to the actual lock itself that might reduce traffic delays. With the mounting backlog in future investments for new construction on the inland waterways system, it is necessary that all possible alternatives be explored that might permit deferral of large investments in new facilities. If non-structural alternatives prove to be an economical means of improving waterway operations in the long-range view, these should be implemented as soon as needs develop. Non-structural alternatives that appear to have the greatest potential for improvement in waterways operation fall generally under the categories of traffic control, communications systems, and removal of obstructions to navigation. Additionally, consideration should be given to methods of handling recreational craft other than through utilization of commercial locks. All Corps' offices are encouraged to submit periodic reports on non-structural measures that have been, or might be, instituted on waterways under their jurisdiction.

In the short time I've had to talk to you I have tried to explain what systems analysis is, why the Corps needs it, where we are now in the development of systems analysis, and what still remains to be done. I have only been able to show you the top of the iceberg -- the main portion is still below the surface and out of our sight. It will take the combined efforts of all concerned - OCE, the Board, the Divisions and especially the Districts and the shipping interests - if we are to come up with an acceptable methodology for systems analysis for our inland waterways. We can because we must. The Corps has a motto "Essayons" - "let us try."

IWR DEEP PORT STUDIES

George Makela

The use of very large ships (100,000 dwt and over) in the movement of bulk commodities in international trade is a rapidly growing practice. The very large crude carriers (VLCCs) have led this trend toward enormous size. Other tankers and dry bulk carriers are also growing but at a slower pace. Economic pressures have not yet been strong enough to induce the construction of U. S. harbor facilities for these very large ships. One reason for this phenomenon is the past capability of the United States to satisfy its own petroleum needs. By contrast Japan and Europe are now almost completely dependent on North African and Middle East crude oil. Most of the existing VLCCs are used in this trade, and numerous deep harbors have been provided at both ends of the routes. The United States already needs to import oil, but our relatively shallow ports, generally less than 40 feet deep, prevent the use of the VLCCs now in common use on other routes. By comparison, the largest of the tankers now have drafts up to about 90 feet.

The United States will grow more and more dependent on foreign crude oil as time goes on. It has been estimated that by 1980 our imports from North Africa and the Middle East will amount to about 15 million barrels a day. This geographical area has about 80 percent of the free world petroleum reserves, so it is inevitable that U. S. imports will originate there. The 15 million barrels a day amounts to about 850 million tons a year. The saving in transportation costs afforded by VLCCs over the ships that can now use our harbors has been estimated variously as being between 1 and 2 cents a gallon. Thus, each of us as an individual will feel the effects of the decision of whether or not to provide deep harbors.

Regarding the energy picture, it is generally felt that the U. S. is not running out of fossil fuels. It is only running out of low cost fossil fuels.

For some time now the Corps has been following the rapid growth in ship sizes, and at the same time, it has been considering the possible future need to accommodate them in our harbors. Some time ago, the Corps attempted to secure authority to study the need for deep harbors on a regional basis. The port industry was opposed on the basis that regional harbors would interfere with the traditional competition between ports. OMB, however, has asked the Corps on several occasions to consider regional harbor facilities as alternatives to deepening particular harbors. In this climate, IWR undertook its initial studies of the deep port problem. These early studies were intended to form a basis for subsequent Corps studies for particular regions. Authorities for these regional studies are now available, and work has been started on them. The continuing work of IWR is being planned to fit in with these just-started regional studies. In this context, this conference can help IWR by identifying District study needs so that they can be incorporated into the IWR program for FY 1973.

My objective here is to describe to you the IWR deep-port studies. I will treat the subject in four phases. The first phase concerns completed work; the second, the on-going IWR work; the third, deep harbor studies by other Federal agencies; and the fourth part, future IWR work. I'll spend most of the time on other agency work and future IWR work. The reason for dwelling on other agency work will become evident as I proceed.

The first completed IWR study on deep harbors was the Cronin report which is entitled: "Preliminary Analysis of the Environmental Aspects

of Deep Port and Superport Operation." Copies have been distributed throughout the Corps. The report contains a useful list of the kinds of things that should be considered in a marine environmental evaluation. The report also recommends for consideration seven items of research. None of the seven are within the authority of the Corps to accomplish, and to my knowledge other Federal agencies who have been made aware of the report have not undertaken any research along the lines recommended.

Now also in the completed category is the A. D. Little report, "Foreign Deep Water Port Developments," which was just recently distributed to Corps offices. We are receiving numerous requests for the report including many from private interests and the port industry. The report has a large amount of background information on European decisions to provide deep harbors. The report was not, however, intended to survey the U. S. needs for deep harbors, so we must be careful about applying the European decisions to the U. S. problem. Nevertheless, one of the more significant foreign lessons is that it would be a gross mistake to examine only the marine environmental effects. Unless strictly regulated, as at Bantry Bay, Ireland, substantial secondary effects will also be felt on the land side of any very deep harbor.

In the on-going studies phase, we have three reports. The most important of these is the Nathan report on U. S. needs for deep ports. It is now nearing completion on the basis of balanced treatment of economics, engineering, and environment. Drafts of the bulk commodity flow projections are essentially complete. Copies of the projections of the oil, coal, iron ore and bauxite have been distributed to interested Corps offices and other Federal agencies. We are soliciting comments on these projections. To

receive consideration you should send your comments in at an early date.

Engineering-wise, Nathan has selected the sites it will consider for deep harbors, is preparing harbor layouts, and is now in the process of pricing them out.

As to the environmental aspects, Mr. Cheny of Nathan has developed a general system for evaluating the effects of any deep harbor facility. He is now in the process of applying this system to the sites and layouts developed in the engineering portion of the study.

It appears that the Nathan report ought to be ready in draft form in about mid-May. The printed report will not be available for distribution until late summer or early fall. The report with its appendixes is expected to contain about 1000 pages.

Also in on-going status are two reports on foreign port visits made by Corps representatives. These reports should have been completed by now, but they have been delayed by other demands on the writers' time. A strong effort is planned to complete them by the end of the current fiscal year.

The third phase of my discussion concerns deep-harbor studies being carried on by other Federal agencies. These studies are brought up because it is essential that future IWR studies complement these other agency studies and not duplicate any of them. The two most important studies in this category are the ones being conducted by the Maritime Administration and the Council on Environmental Quality.

The Mar Ad studies have as their ultimate objective the provision of deep, U. S. home ports for the very large bulk cargo carriers which the Administration hopes to construct under the new ship subsidy law. Mar Ad

has been working both in-house, and with a contractor. The contractor, Soros Assoc., is expected to submit their three-volume report next week. It will be distributed for multi-agency review in Washington. Soros, primarily an engineering organization, put substantial effort into developing the designs for an open-sea island to be located off Cape Henlopen outside the entrance to Delaware Bay. The crude oil landed at the island terminal would be transshipped to shallow harbors by sea-going barges. The objective of this effort was to develop an environmentally safe and politically acceptable design. The island designs have been discussed with potential users and state representatives. On the basis of these talks Mar Ad is also examining a terminal inside Delaware Bay, a concept that had been abandoned previously as flying in the face of political reality. The Soros report will also consider some 30 other potential U. S. deep harbors, some of which might also handle bulk commodities other than oil.

There are indications that Mar Ad is uneasy about the fact that to date no one has studied the need of a deep port from a truly regional viewpoint. The Corps, as far as I know, is the only organization with this mandate.

Mar Ad is also working with a Texas organization on performing a Texas deep-port study. The current plan is to have Mar Ad provide one half of the $600,000 now estimated to be required for the 18 month study. Mar Ad has returned a proposed statement of work to Texas for comment. The prospects for accomplishing the study are not completely optimistic. At any rate, Mar Ad appears to regard the output from this Texas study as input to the overall Corps study for the Gulf Coast.

The State of Louisiana is considering a study similar to the one being considered for Texas.

CEQ is pushing ahead with their study of the environmental effects of large petroleum tankers in the U. S. trade. The CEQ study procedure is to make maximum use of on-going studies and to supplement these by contract studies and in-house studies by the participating agencies. The procedure is outlined in a CEQ report which I have reproduced for distribution at this afternoon's work group. At the end of the CEQ report is a listing of 22 more or less independent tasks into which the study has been divided.

The first CEQ task, selection of sites, has been completed on the basis of the Nathan and Soros studies. A draft of the report on this task accompanies the CEQ material I have referred to.

Reports on the tasks relating to projection of oil imports are essentially complete. These projections are based on the Nathan studies for IWR.

A detailed CEQ study of oil spill probability has been started by the Coast Guard, EPA, and Mar Ad. This aspect of the deep harbor problem is vital to the environmental evaluation, and it will provide a valuable input to the Corps' studies. The oil spill probability study will consider the seven selected sites, various kinds of terminal facilities at the sites, and various sizes of ships. The do-nothing alternative will also be studied to provide a baseline.

The oil spill probability and the construction and operation of the deep harbor facilities will then be evaluated in terms of their primary effect on the environment. This will be accomplished by MIT, the State University of New York, the University of Delaware, Louisiana State University, and Texas A&M. CEQ has received proposals from most of these universities and is now in the process of reviewing them, with IWR participation, in preparation

to awarding contracts. IWR is considering assuming the payment and the administration of the contracts with LSU and TAMU. These studies, being directed to the Mississippi Delta and the Galveston-Freeport areas, will provide direct inputs to the Corps' Gulf of Mexico study. When they become available, I will distribute the proposals to interested Corps offices. The university environmental studies are expected to cost $20,000 to $35,000 each. I would judge on the basis of this cost that the Corps will find it necessary to supplement the CEQ effort with a substantial effort of its own.

Of great interest to the Corps is the CEQ contract which I understand is being awarded to A. D. Little, Inc. to evaluate the secondary effects and costs of deep-water oil terminals at the seven selected sites. The ADL proposal is among the papers to be distributed at the work session. Work is to be initiated by 1 April 1972, and completed by 1 October 1972. The importance of secondary effects was pointed out in the ADL report to IWR on foreign experience with deep harbors. The effects noted in the report include industrial and economic development and the accompanying social dislocations and environmental consequences. The ADL team which performed the IWR study will also be involved in the CEQ study.

The fourth and last phase of this discussion concerns the future IWR program. This program has not yet been fully defined, but at the present it appears that further IWR support of the current CEQ study effort along the lines I just described would advance our own studies.

A potential study being considered for contract by IWR would consist of analyzing the petroleum system of which deep harbors are but a small part. For example, we are talking about an investment of $1 billion, perhaps $2 billion in deep harbors. By 1985, for comparison, an additional

investment of $140 billion would be required to meet U. S. needs in oil and gas production, oil refining, and oil transportation. If we look at the entire energy picture, the additional expenditure required by 1985 might amount to $375 billion. The petroleum system which would be analyzed would encompass the petroleum sources, the crude oil transportation systems, the refineries, and the product transportation systems connecting to U. S. market areas. The objective of the study would be to (a) determine the least costly total petroleum system for the United States considering both the harbors and conventional and shallow-draft ships, (b) estimate the added economic cost of other systems which might be favored for political or environmental reasons, and (c) to estimate how sensitive the study results are to changes in study inputs, including the time when a deep-port starts operations, whose values are uncertain at this time. The effects of various locations for deep harbors and refineries could be tested on a national scale. Such a study would help to tie the national port policy to the national energy policy when such a policy is formulated. A copy of a paper on a oil system study will be available for distribution at the work session. A paper describing this proposal in more detail will also be available at the work session.

Very important to all Corps regional deep port studies are the legal, financial, and managerial aspects of performing the studies, and of the construction, and the operation of a deep port. How should all the interested agencies, political and business, participate? What are the legal constraints? What zoning would be required to control the landside environmental effects? How should all cost bearers and beneficiaries be assessed?

What authorities and compacts are required before proceeding? What organization should undertake the project? What financing and repayment policies should be adopted? What is the Federal interest in a deep harbor? How should costs be shared? The problem is such a broad one that its boundaries still remain undefined. Since the problems are common to all regional deep harbor studies, it appears appropriate for the IWR to consider a contract in the field. A descriptive paper on this study proposal will be available at the workshop.

Another potential IWR contract study would consist of examining the secondary effects on existing harbors if some other site were selected for development as a regional harbor for very large bulk cargo carriers. This potential study area was suggested by Bruce Putnam of ADL who worked on the IWR foreign port contract and who will work on the CEQ contract on secondary effects of terminals for VLCCs. This potential IWR contract study would not duplicate any CEQ effort.

Other potential IWR study areas are as follow:

a. Tie the deep-harbor studies more closely to the origin and destination studies of the Corps.

b. Define the relationship of deep harbors to inland waterways.

c. Examine harbor configurations for deep-water ports. This would consist of determining what port components are required to handle ships and various bulk commodities in deep harbors, and how these components should be arranged to permit most efficient use of the facilities. Port configurations for multi-use vessels would also be examined.

This afternoon's workshop will take up the proposed IWR studies, SPD experiences in deep harbor studies, and district and division concepts of

researchable areas in the deep harbor field. Also, Mr. Bertrand de Frondeville of A. D. Little is here and I expect him to come up with ideas on deep port problems requiring research. Mr. de Frondeville participated in the foreign port study for IWR and is probably more expert in the field than anyone here.

I have also put together a few slides on the deep port problem and how the problem was solved at selected ports in the Middle East and Europe. If you are interested and we have time, I can show them this evening in Room 521, say at 7:30 o'clock.

AN EXPERIMENT IN DISCRIMINATE ANALYSIS

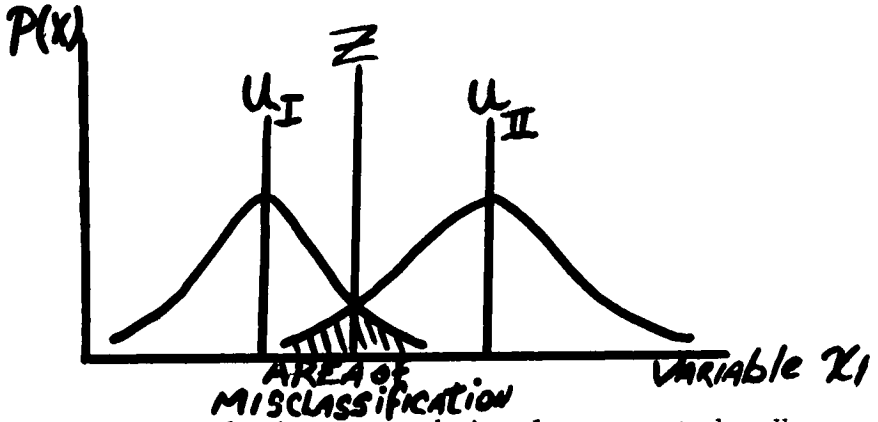
Economics has increasingly become an exacting science with the aid of mathematical modeling made possible by the use of modern high speed computers. More and more academicians and practitioners alike have progressed from intuitive thoughts to mathematical orientation and frequently employed sophisticated techniques in economic research. We shall examine one such technique here and explain its usefulness as well as its limitations as a tool for economic research.

The discriminant analysis attempts to establish linear function which would separate a universe into different populations or groups. This operation classifies or describes a random observation to a population which possesses the most similar a priori characteristics with minimum misclassification. To understand the method of analysis, a brief summary of the mathematical concept involved is presented below.

Two Population Cases

This section is confined to the allocation of a random sample into one of two populations having known probabilities.[6/] Assume a single variate case X_1 having two normally distributed populations with known means U_1, U_2 and a similar standard deviation for both populations, where U_1 represents the mean value of variable X_1 for population one and U_2 the mean value of variable X_1 of population two. Allocating the random sample to the proper region requires that the means are not equal. The boundary line between the population becomes the arithmetic mean of the total sample.

In the usual case where U_1 is less than U_2, the natural method of separating permits the placing of an observation into population II if the value of X is greater than $1/2(U_1 + U_2)$ and into population I if X is less than $1/2(U_1 + U_2)$. In other words, if a random observation has an X_1 value less than Z, it will be placed in population I; if the random sample X_1 is greater than Z, it will be placed in population II.



In Figure 1, the two populations are obviously separated. However, there exist two types of possible misclassification as indicated by the area of overlap. In this area some population I observations are included in population II and vice versa. The misclassification occurs because the tails of each distribution overlap with some of the population lying on the other side of the boundary line.

$$\frac{X - U_I}{\sigma} > \frac{\frac{U_I + U_{II}}{2} - U_I}{\sigma} = \frac{U_{II} - U_I}{2\sigma} = \frac{\delta}{2\sigma}$$

when $\gamma = (U_1 - U_2)$ equals the distance between the means.

Increasing the distance between the two means separates the populations further apart and reduces the overlap area. This divergence minimizes the number of misclassifications. To accomplish the widening of the split requires more than one variable. Let's examine a multivariate case. Assume there exists a number of variables normally distributed, denoted by $x_{iw} (i = 1,2,\ldots P; w = 1,2 \ldots n)$, which classify the universe into two populations by separating the means of the two populations designated by $\delta_i = \bar{x}_i^{I} - \bar{x}_i^{II} (i = 1,2 \ldots P)$. To discriminate between the means a linear function is developed which separates the two sets of variables.[7]

$$Z = a_1 d_1 + a_2 d_2 \ldots a_p d_p$$

This function Z, should be maximum relative to its variance and the variance must be proportional to

$$B = \sum_{i=1}^{P} \sum_{m=1}^{P} k_i k_m \sum_{w=1}^{n} x_{iw} x_{mw}$$

By keeping the variance constant and forming a Lagrange multiplier, a maximum is obtained:

$$F = Z^2 - \lambda Q = \sum_{i=1}^{P} \sum_{m=1}^{P} k_i d_i d_m - \lambda k_i k_m \sum_{m w=1}^{n} x_{iw} x_{mw}$$

This function can then differentiate partially with respect to $K_m (m = 1,2 \ldots P)$. It can be simplified to obtain $d_m \sum_{i=1}^{P} k_i d_i = \lambda \sum_{i=1}^{P} k_i \Sigma x$.

This equation can then be set up to form a set of simultaneous equations. In this case two linear equations are generated with a certain R^2 value which determines into which population an observation should be placed. If an observation has an $R^2 < Z$ the sample is placed in population I and $R^2 > Z$ the sample is placed in population II.

The multivariate case involves the separation of universe into several mutually exclusive regions. The regions will represent individual and different populations and any observation in those regions shall be considered from that population. The types of misclassification now become more complex and may overlap into more than one population. As a result, we will attempt to minimize the number of misclassifications that might occur.

Using T. R. Anderson's method[1/] a discriminant function which minimizes the number of misclassifications can be derived. With a priori probability of selecting an observation from π_i, that displays $\pi_i = N(\mu' \Sigma)$ (i = 1,...m).

Where

μ' = the mean of each variable and no two means for the same variable are identical.

Σ = covariances which are similar.

The discriminant functions permit the separation of the population into several different regions. This case assumes that the costs of misclassification (C, j/i) are equal. These functions may be represented by

$$u_{jk}(x) = \log \frac{P_j(x)}{P_k(x)} = \left[x - \frac{1}{2}(\mu^{(i)} + \mu^{(x)})\right] \Sigma (\mu^j - \mu^k)$$

The regions of classification $R_1, \ldots R_m$, can be determined in the following manner so as to minimize the error. The conditional probability of an observation coming from π_i is

$$\frac{q_i P_i(x)}{\sum_{k=1}^{m} q_k P_k(x)}$$

If this observation is classified as from population π_j, the expected loss becomes:

$$\sum_{\substack{i=1 \\ i \neq j}}^{m} \frac{q_i P_i(x)}{\sum_{k=1}^{m} q_k P_k(x)} c(j/i)$$

By selecting j so as to minimize the expected loss we derive

$$\sum_{\substack{i=1 \\ i \neq j}}^{m} q_i P_i(x) c(j/i)$$

Assuming the a priori probabilities are known, the region R_j may be defined by those x's that satisfy

$$R_j: \; u_{jk}(x) > \log \frac{q_k}{q_j}, \; k = 1, \ldots, m; k \neq j$$

Problems

Some of the difficulties and limitations should be recognized before employing such a method.[5/]

a. The solution of discriminant analysis is not necessarily optimal since there is no guarantee that all observations will be allocated to the correct population. The residual of misclassification becomes less as more

variables enter. However, attempts to resolve these undecided cases will be at the expense of distribution-free nature (randomness) of the method.

b. Another problem of the foregoing method is that it does not discriminate between populations that exhibit different dispersions but have the same mean.

c. The tool does not provide for a procedure to classify new points which fall outside all known populations.

d. The alteration of one variable of one group drives that population closer to a neighboring distribution. The result leads to an inadequate discrimination and increases the probability of misclassification.

Experiment

The experiment attempts to separate a known a priori universe of transportation into individual modes by employing discriminant analysis. This procedure establishes linear equations under various conditions and enables the classification of unknown movements given those coefficients.

Data

The universe is composed of information gathered in the summer of 1971 by IWR-ORD team.[2/] The data pertains to the actual bituminous coal movements in the middle and lower Ohio River Basin. From this region 315 complete observations that moved by one form of transportation were recorded. The breakdown of the total was:

227	Rail	= RR
33	Barge	= BA
19	Unit Train	= UT
17	Truck	= LT
9	Joint Movement	= JM

A complete observation consists of information on several variables that enable mathematical distinctions between the modes. These are the means for these variables:

	Rail	Barge	Unit	Joint	Truck
X_1 = Annual tonnage	7,794	95,119	141,822	856	1,913
X_2 = Distance miles	193	252	117	1,118	89
X_3 = Time - hours	136	88	45	131	4.8
X_4 = Average size of shipment	1,065	7,518	3,416	2,514	165
X_5 = Tariff	$3.89	0.92	1.78	3.43	2.69
X_6 = Handling Cost	$0.47	0.49	.21	.48	0.39

Annual tonnage equals the quantity of coal that enters the plant premise in one calendar year. Distance refers to the number of miles a cargo moves to reach its destination by a particular route. Time equals the number of hours a vessel actually requires to reach a destination, including travel time and delays. Average size of shipment refers to the tonnage an individual receives in usual delivery. Tariff is the direct cost the shipper pays for services to the transport company. Handling cost is for unloading and for storage.

A modified BMD 07M[3/] on a Univac computer was employed for this analysis. The program enables the analyst to split a universe into several different populations. Two outputs from the program shall be discussed in order to analyze the results. First, the D^2 values allow for the interpretation of how discriminating the variables are on the universe. It reveals the generalized distance that each group is separated from the other.[4/] The lower the values the more similar the populations are to each other.

$$F(A,B) = \left[\frac{(N-P+g+1)\, n_a n_B}{P(N-g)\,(n_a+n_B)}\right]$$

$$D^2(A,B) = \sum_{i=1}^{P}\sum_{j=1}^{P} \sigma^{ij}(\chi_{iA} - \chi_{iB})$$

N = total number of observations

p = number of variables

g = number of groups

n_a = number of observations in Group A

n_b = number of observations in Group B

(A,B) = the distance between Groups A and B

σ^{ij} = the ij th element of th universe of the variance-covariance matrix

Xi_a = the mean of the i th variable for Group A

Xi_B = the mean of the j th variable for Group B

Table I shows the effect of an entering variable on discriminating between the modes. Table IA enters variable X_1, annual tonnage, separates barge and rail population quite sufficiently but is unable to distinguish between rail and joint movements. Population RR and JM are very similar since they have a low D^2 value (18). From Table I, (B and C) the D^2 value/or RR and JM has increased with addition of variables X_2 and X_3. The assumption that the addition of more variables will increase the distance between the means is not always true. Although the parameter might further separate one population from another, it might in the process, reduce the distance among other populations. This phenomena may be observed in any of the following tables B-F. For example, as more variables enter, there is a decrease of the D^2 values for RR and JM and the populations tend to become less distinguishable. The distance between the rail-joint appears to be approaching each other while barge-joint tend to separate as each new

variable is added. Thus, the problem of selecting a parameter to be included in the analysis becomes a problem of trade-off between sensitivity and selectivity desired by the analyst.

TABLE I

A) D^2 VALUE - DEGREES OF FREEDOM 1 Variable X_1

POPULATION	POPULATION COALRR	COALBA	COALUT	COALJM
COALBA	664498.			
COALUT	930824.	78072.		
COALJM	18.	183521.	331060.	
COALLT	1975.	332207.	576178.	852

B) D^2 VALUE - DEGREES OF FREEDOM 2 Variable X_2

POPULATION	POPULATION COALRR	COALBA	COALUT	COALJM
COALBA	354577.			
COALUT	466144.	57817.		
COALJM	837665.	640744.	789713.	
COALLT	24284.	216767.	292585.	736376.

C) D^2 VALUE - DEGREES OF FREEDOM 3 Variable X_3

POPULATION	POPULATION COALRR	COALBA	COALUT	COALJM
COALBA	266842.			
COALUT	352663.	43375.		
COALJM	583804.	430514.	524890.	
COALLT	161088.	188585.	208125.	502573.

D) D^2 VALUE - DEGREES OF FREEDOM 4 Variable X_4

POPULATION	POPULATION COALRR	COALBA	COALUT	COALJM
COALBA	401707.			
COALUT	266607.	145913.		
COALJM	442177.	347090.	401599.	
COALLT	133269.	294693.	157184.	392652.

TABLE I (Cont'd)

E) D^2 VALUE - DEGREES OF FREEDOM 5 Variable X_5

POPULATION	POPULATION COALRR	COALBA	COALUT	COALJM
COALBA	515609.			
COALUT	226113.	151131.		
COALJM	426935.	277340.	344929.	
COALLT	109522.	350242.	141897.	382836.

F) D^2 VALUE - DEGREES OF FREEDOM 6 Variable X_6

POPULATION	POPULATION COALRR	COALBA	COALUT	COALJM
COALBA	474606.			
COALUT	187794.	144799.		
COALJM	354600.	242821.	286483.	
COALLT	91288.	315680.	17999.	318002.

TABLE II

A)

POPULATION	NUMBER OF CASES CLASSIFIED INTO POPULATION - COALRR	COALBA	COALUT	COALJM	COALLT
COALRR	22	6	1	35	163
COALBA	2	7	8	11	4
COALUT	0	1	9	8	0
COALJM	1	0	0	1	7
COALT	3	0	0	0	17

B)

POPULATION	NUMBER OF CASES CLASSIFIED INTO POPULATION - COALRR	COALBA	COALUT	COALJM	COALLT
COALRR	161	6	2	1	57
COALBA	14	7	8	0	3
COALUT	4	1	9	0	4
COALJM	4	1	0	4	0
COALLT	4	0	0	0	16

C)

POPULATION	NUMBER OF CASES CLASSIFIED INTO POPULATION - COALRR	COALBA	COALUT	COALJM	COALLT
COALRR	171	3	3	1	49
COALBA	14	5	9	0	4
COALUT	4	0	9	0	5
COALJM	3	1	0	4	1
COALT	3	0	0	0	17

D)

POPULATION	NUMBER OF CASES CLASSIFIED INTO POPULATION - COALRR	COALBA	COALUT	COALJM	COALLT
COALRR	169	9	3	1	45
COALBA	11	13	5	0	3
COALUT	4	0	9	0	5
COALJM	3	1	0	4	1
COALLT	3	0	0	0	17

E)

POPULATION	NUMBER OF CASES CLASSIFIED INTO POPULATION - COALRR	COALBA	COALUT	COALJM	COALLT
COALRR	171	4	4	1	47
COALBA	2	21	6	0	3
COALUT	4	0	9	0	5
COALJM	3	1	0	4	1
COALLT	3	0	0	0	17

F)

POPULATION	NUMBER OF CASES CLASSIFIED INTO POPULATION - COALRR	COALBA	COALUT	COALJM	COALLT
COALRR	171	6	3	1	46
COALBA	2	22	5	0	3
CAOLUT	4	1	9	0	4
COALJM	3	1	0	4	1
COALLT	3	0	0	0	17

In addition, the program allocates an individual case into that population with the highest probability for proper classification. The results of this procedure are tabulated into a summary chart. Table II displays the number of misclassifications that occur for each variable and the population where these errors were placed. The summary tables II A-F represent the classification as each variable enters the problem.

These tables show that the additional information improves the classification. The entrance of more variables reduces the area of overlap and lowers the probability of misclassification. Table II-A classifies the results based on one variable. In this case 22 of the 227 rail movements were correctly allocated, while the remaining 205 were misclassified in the other population. It can be observed that the rail classification improves with the entrance of more information. For example, in Table II C when variables X_1, X_2 and X_3 enter, the number of correct classifications increased from 22 to 171 and the number of misallocations was reduced to 56. At the same time the distances between rail and other populations are widening. Consequently, lessening the overlap of different populations decreases the probability of misclassifications and results in a more homogenous modal split.

The brief exposition explains one use of discriminant analysis for solving economic problems. This tool enables analysts to separate statistically a given sample into several populations and predict the modal choice of unknown firms given that firm's parameters. The coefficients of parameters permit the classification of unknown demand of transportation into one of those populations. The procedure helps to identify the most important economic factors in the decision by firms to select a particular mode.

With certain manipulation the discriminant analysis can be used for several other tasks aiding in projecting future economic effects:

1. Denand analysis - vary one parameter of one population to observe the with and without condition.
2. Cluster analysis - using no prior probabilities for the observation.

These benefits plus the ones already mentioned make discriminant analysis a useful tool for economic research.

BRION SASAKI

FOOTNOTES

1/ T. R. Anderson, Introduction to Multivariate Statistical Analysis, Wiley & Sons, New York, 1958.

2/ C. A. Berry, J. Cannelli, J. Dworkin, L. Elliott, L. Kuhn, B. Sasaki, IWR-ORD Transportation Mode Data Study, U. S. Army Corps of Engineers, Cincinnati, 1971.

3/ W. J. Dixon ed., BMD Biomedical Computer Programs, (Berkeley: University of California Press, 1968.

4/ D. A. Gansner, D. W. Seegrist, G. S. Walton, "A Technique for Defining Subareas for Regional Analysis," Growth & Change, Vol. 2 No. 4, October 1971.

5/ M. G. Kendall and A. Stuart, The Advance Theory of Statistics, Vol. 3, 2nd Edn., Hafner, New York, 1968.

6/ G. W. Snedecor and W. G. Cochran, Statistical Methods, 6th Edn., Iowa State University Press, Ames, Iowa, 1968.

7/ G. Tinter, Econometrics, Wiley & Sons, New York, 1952.

Richard J. McDonald

Research in Social and Environmental Aspects of Planning

When one of the staff analysts of the Center for Advanced Planning is pressed for a description of his duties at IWR, he frequently avoids the issue by saying, "the Center for Economic Studies covers the economic sector of water resources planning, we cover everything else." We are sometimes allowed to get away with this much generality. However, my task here today is to be more specific about the research activities of the Center for Advanced Planning and to attempt to show how all of the various areas of interest at IWR tie together.

The Corps of Engineers water resources planning process can best be described as a series of relatively simple activities which are melded together in a complex and interactive manner such that the output of planning is greater than the total of its parts. I say relatively simply activities because economic analysis, population forecasting, engineering design, etc., are relatively simply only when compared to the expected end product of planning, which is an optimum solution, measured across complex economic, social, and political value systems, to a complex combination of water resources problems and needs.

Let me introduce the complexity of the problem we are dealing with by showing you several graphs which display the nature of the objectives of the planning process and explore the evolution of planning requirements in recent years.

(VIEWGRAPH 1)

The first graph was developed by Pat Johnson of our staff to illustrate two things: (1) that the complexity of the planning process is increasing, and I don't think anyone would argue with that; and (2) the elapsed time period between significant changes in water resources planning philosophy and mission is collapsing at an ever increasing rate. Note, for example, that the era that we have labeled control spans some 25 years, the allocate era lasted for only 12 years, the emphasis on protection has predominated for some 8 years and now, with the introduction of Section 122 of the 1970 Flood Control Act, another era, probably of a short duration, has arrived. Note also that the proposed Water Resources Principles and Standards doesn't show up on this graph yet. It is difficult to predict what our planning requirements will be 5 or 10 years from now, but based on this picture of exponentially increasing complexity, they will be considerably more difficult to deal with than they are today.

Another way of presenting the evolving nature of planning is shown on the next slide.

(VIEWGRAPH 2)

Note the extra dimension shown here. The last column lists the quantifications of a planner which are in a sense required to successfully accomplish his job. The evolutionary (and some might say, revolutionary) changes in planning scope and emphasis seems to be causing a shift from the technologic specialist toward some sort of philosophic man, but note that the skills listed are not independent, they are additive. This leads

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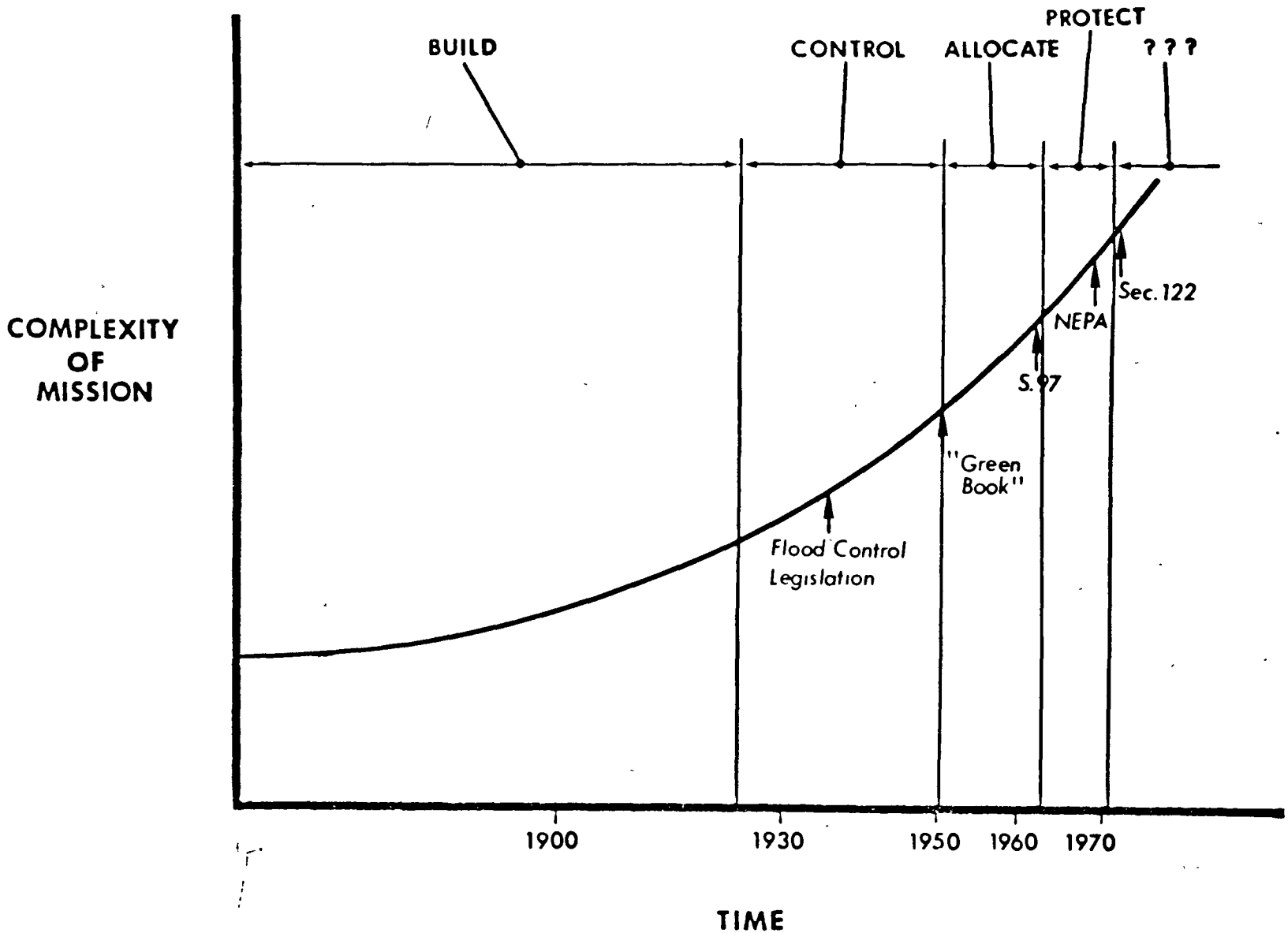

VIEWGRAPH 1

NEEDS	SCOPE*	OBJECTIVE(S)*	DATA REQUIREMENTS*	PLANNER QUALIFICATIONS*
Flood Control Navigation	Single Purpose	Technical Soundness Manage the Economy	Engineering Data Macro-economic Data	Engineer
Beach Erosion Recreation Water Supply Low Flow Augmentation	Multiple Purpose	Economic Efficiency	Micro-economic Data	Economist Coordinator
Redistribution of Income Environmental Enhancement	Multiple Objectives	Optimum Mix	Social Attitudes Ecologic data Welfare needs	Inter-discipline Sociologist Ecologist Aesthetic
Land Enhancement Land Use Planning Secondary Benefit Analysis	Total Objective	Coordinated Growth/ Stability	Comprehensive Human need analysis	Visionary Utopian Federalist

*All columns are cumulative

to an inevitable but rather Utopian conclusion; all we need to perform quality planning under present and near-future conditions are supermen planners, who are well versed in the disciplines of engineering, economics, biology, sociology, law, ad infinitum, but in addition, he must also possess the social and aesthetic sensitivity of a Henry David Thoreau or a Thomas Aquinas. Also note that this graph displays an estimate of the step beyond multiple-objective planning.

Without getting into an extended argument over the terminology I used to describe future planning objectives, requirements, and qualifications, I would like to briefly fill you in on some of the thinking behind it.

We are all familiar with some of the major new missions of the Corps and some of the changed emphasis on old missions. Waste water treatment has long been acknowledged as the missing link in the water planning cycle. With the passage of the Water Supply Act and the opening of the multiple purpose concept to include low flow augmentation, it was only a matter of time until the Corps had to refine its studies of the relationships between water quantity and water quality and include all water quality alternatives (including waste water treatment) in water resources development planning. That time is now arriving. Another example has been the expansion of the role of flood plain management as a viable alternative to structural flood control. At one time, local zoning considerations and differences in local cost-sharing contributions were seen as insurmountable obstacles to the consideration of non-structural flood control. There are still many problems, but the trend is clear. Flood

control planning is a whole new ball game, if not now, then in the foreseeable future.

There are still more "hand-writing on the wall" kinds of concepts floating around at the present time. Their time has not yet arrived and their implications to the form and substance of water resources planning is not clear.

We have seen over the past 5 years the emergence of a new emphasis on the environmental and the social effects of water resources development activities. We have had some success in our efforts to identify, measure, and account for these effects when we formulate and evaluate alternative plans. But we still have a long way to go, because the growth of emphasis and concern for environmental and social well being values have generated planning concepts which are entirely foreign to our experience and for which we are poorly prepared to comprehend and adjust to. Zero population growth is one of these concepts, resource consumption at a renewable rate is another, and ecologic balance is yet another. Change as the status quo instead of equilibrium as the status quo; population dispersion, the seeming demise of the Judeo-Christian ethic of man's dominion over nature, the culture of the flower child and the commune; the list goes on and on.

How does one go about converting these kinds of concepts and ideas into a research program? How do you go about operationalizing this kind of a dim view of the future? The Center for Advanced Planning has struggled with the problem of defining the future of water resources planning since the day we opened for business. Thus far, our approach has been to conduct a broad-range search of other sciences and disciplines seeking concepts and techniques which might be converted to our own problem-solving apparatus.

In other words, we formulate tentative research programs on the basis that every science, whether established or emerging, may have something to contribute to the water resources planning process. I'll lay out a few examples of what I mean by this. It goes without saying that the biological sciences form the keystone for research on the environmental impacts caused by water resource development activities. But the contribution of some of the other disciplines are not so readily apparent. We have looked at modern marketing techniques for ways to improve the distribution and the impact effectiveness of planning information to the public; we are looking at modern management concepts in order to better understand the motivation and organization of water development project proponents and antagonists; and we are looking to the developing science of futureology for better forecasting techniques, to name but a few.

We then go through a matching process, trying to pair what we know about potential problem-solving techniques with what we know about Corps planning problems which need solution. We have or are developing formal methods of surfacing research needs through literature searches of other on-going planning research programs, through monthly meetings with policy-makers from OCE, and through the yearly PPB research and development program budget exercise. We also have informal contacts with universities and private research facilities throughout the nation. In addition to these formal and informal contacts within the Corps and the research community, there is another and most important, indicator of research needs, namely, a study of legislation, such as the 1970 Flood Control Act, and executive orders, such as SD 97. Using all of these inputs we try to estimate what the planning criteria and requirements will be 5 years in

the future, and then we formulate a research program that will produce the necessary policies and techniques which will enable us to perform water resources planning according to these requirements. In short, we try to figure out where we're going to be and what we're going to be faced with 5 years from now, and then we try to figure out how to get there.

Now that I've gone through this description of the research task to be accomplished, I'll proceed with the main topic of my talk this morning, namely, a description of the research program currently underway in the Center for Advanced Planning. I felt that the preamble was necessary in order for you to understand the context within which our program is formulated and the way in which it is supposed to hang together.

I have classified our research activities under two broad categories. One I will call Environmental and Social Considerations; the other is Investigative Methods and Objectives.

(VIEWGRAPH 3)

The Environmental and Social Values sector is aimed at developing the concepts, standards, criteria and procedures needed to identify and evaluate the environmental and social effects of Corps water resources projects. It includes the development of environmental and social data systems and indices, monitoring the state-of-the-art of the environmental and social sciences, conducting specialized and interdisciplinary research, and testing developed concepts and procedures.

The sublist labels Activities represents a cross-section of the kinds of studies currently underway which fit under the Environmental and Social Values label.

ENVIRONMENTAL AND SOCIAL VALUES

-Develop concepts, standards, criteria and procedures.

-Develop basic data collection and retrieval systems.

-Monitor the development of the environmental and social sciences.

-Conduct specialized and interdisciplinary research.

-Test developed concepts and procedures.

Activities

1. Environmental impacts of water resources development.
2. Preliminary study of the ecological impacts of deepwater port development and supership operation.
3. An information system for the evaluation of nonmarket outputs - Honey Hill.
4. Requirements for social impacts research.
5. Systematic oversight of current environmental research and development.
6. Resiliency concept development.

The Environmental and Social Values sector directly addresses the formulation and development of several of the new objectives which are currently in the process of being included in planning under the WRC Principles and Standards approach.

On the other hand, the Investigative Methods and Procedures area covers a number of activities which closely relate to the Corps planning process, but which are best discussed in terms of planning activities instead of planning objectives. The research studies I've just described are usually thought of in terms of the purpose of planning, the goals against which plans are evaluated. The next set of studies address the activity of planning, that is, the way that you perform the planning task.

(VIEWGRAPH 4)

This research program seeks to improve the efficiency and the effectiveness of the Corps water resources planning process. It involves (1) the investigation and evaluation of existing planning methods, procedures and criteria, and (2) the development of new and more effective planning techniques. Some of these are listed on the slide.

Before I open it up for questions on our program, I would like to briefly touch on the relationship between what we do at CAP and the theory and practice of economics.

If you knew what I knew about the details of some of our studies, you would know that we frequently get into questions concerning evaluation. We are actively seeking evaluation techniques which are outside of the boundaries of economic analysis models. Multi-obejctive planning places a broad new layer of evaluative analysis upon the planning process; it

INVESTIGATIVE METHODS AND PROCEDURES

-Existing methods, procedures and criteria

-New and more effective planning techniques

  -public involvement
  -systems analysis
  -social and technological assessment

Activities

1. Data use studies.

2. Multi-objective planning frameworks.

3. Management of uncertainty.

4. Technical assistance for public participation activities.

5. Effective communication.

6. Systems dynamics study.

7. Planning short courses.

demands that some way be found to trade off economic, environmental, and social benefits and costs. The reason we are delving into so many sciences and disciplines is partially due to the fact that the science of economics has not expanded to accommodate many of the new planning factors which must be considered, and we are looking for something else to fill the void.

I see it as not a limitation of the science itself, but as a limitation in the application of the basic concepts of economics in a comprehensive manner. Based on my rather limited exposure to economic theory, I know for instance that supply-demand models are primarily meant to be models of human behavior in that they provide the means to preduct how a consumer or a producer reacts when confronted with a given marketing situation. But I have only recently seen any effort to superimpose this model on the identification of needs as specified in annual Corps programming and budgeting documents. Let me cite another example. Relative scarcity is one of the most powerful concepts of the science of economics, but I have yet to see the application of the concepts to resolve a confrontation between the desire to develop a wild river and the desire to keep it as a free-flowing stream. Yet another example. Water resource economics, more than any other of the planning sciences, is sensitive to the future. Changes in the demand and supply picture for agricultural goods, flood plain land, water-based recreation, etc., may have a significant impact on the decisions that are made today and particularly on the options which are foreclosed by anything we do or don't do. But in my opinion, the effort to study the impact of alternative futures on economic projections is not on a par with the effort to refine the

methodological aspects of economic analysis per se. One final example. Economic man forms the basis for all resource allocation decisions as long as resources are scarce and survival is in question. But even though a sizable proportion of U.S. citizens still live on a sustenance level, another sizable and vocal proportion has transcended its survival difficulties and other values are beginning to dominate its market behavior. Economic policy, as expressed through current Corps of Engineers evaluation techniques, has not caught up with our gut-reaction feelings toward the importance of the income reallocation effects of projects, particularly in depressed areas. In addition, all of us, including the Corps, are only now beginning to recognize and account for the shift to higher order values such as those exhibited by conservationist and preservationist interests. In fact, benefit-cost analysis as presently performed reduces rich and poor, farmer and poet, and economic and aesthetic man to one common denominator, the dollar sign. Such aggregation at one time may have been permissible, but many seriously wonder whether the equation still holds.

We are still not working together to resolve many of the basic problems of plan formulation and evaluation. We are still attempting to refine existing methodologies to a higher degree of precision, when what is really needed is a broad-based conceptual study of the planning process itself and the causal relationships between the development decisions we are making today and their effect on the short and long-range welfare of mankind. Each of us, in his own way, is guilty of tunnel vision, that unique cognitive characteristic of man which makes the most immediate problem the most important, and leads to the solving of familiar problems

first because it is work to expand our horizons into unfamiliar territory. Tunnel vision is what the bureaucracy is designed to promote, wherein each man has his niche, his own role to play, his own task to handle. The technical specialist fits easily into a tunnel-vision system, and that goes for planners, for economists, for policy-makers, and for research analysts as well.

But the kinds of problems I've outlined this morning, and the kinds of multi-objective problems discussed yesterday, simply can't be addressed by tunnel-vision specialists. What is needed is truly interdisciplinary research, wherein economics is melded to the other natural and social sciences, and knowledge from several different sources is combined to come up with new and innovative plan formulation and evaluation techniques.

The role of the field planner, and the field economist, in inter-disciplinary problem solving is of equal or perhaps greater importance than that of the research analyst. For it is necessary for you and your colleagues in the field offices to work closer together than you have in the past so that you are exploring issues, defining problem areas, generating alternatives, and formulating and evaluating solutions together. The kind of synergism that Dr. Schaeffer referred to yesterday cannot occur without interaction. If this requires some other form of planning organization, if we have to stop labelling ourselves as economists or planners, if we have to throw away a lot of outmoded ideas and techniques and swim around in a conceptual vacuum for awhile, so be it. All I'm really saying is that it will not be possible to confront many of our planning problems by learning how to do more precise economic analysis, or design cheaper structures, or write better environmental impact

statements. A broad-ranged approach to planning which confronts concepts which I have called "hand-writing on the wall" concepts is necessary. The field economist, and the field planner, can aid us considerably by posing research problems to us in a way that requires a comprehensive, all-inclusive inter-disciplinary research response. In order to do this, it will require not a small amount of sacrifice on your part, since it will be necessary to forsake some attention to immediate, short-range, project-specific problems and devote more time to the contemplation and formulation of comprehensive problem areas. But such sacrifice is essential if our planning is to be effective and meaningful. The Corps of Engineers was not prepared to fully respond to the water pollution crisis, we were not prepared to respond to the preservationist philosophy, and we are barely ahead of the urban problems area. Unless we, meaning all elements of the agency, work together, we will not be prepared to respond to zero growth, or population dispersion, or new forms of transportation or energy production systems, or different kinds of life style and human interaction, or even to a water crisis, if it comes to that. And if you're not thinking hard about problems like these, then you simply can't call yourself a planner.

SOME PROBLEMS AND ISSUES IN WATER-ORIENTED RECREATION RESEARCH

I. Introduction

The Corps of Engineers has been a major source of recreation opportunities along with other government agencies and private enterprises. In many regions of the United States, significant portions of the recreation activities are carried on in reservoirs, camp grounds, parks, beaches, rivers and streams which have been built, designed, or protected as parts of the Corps civil works program. The potential for the Corps to play an even greater role as a major supplier of recreation facilities is almost unlimited considering the magnitude and diversity of the recreation resources which could be made available to the public through Corps traditional (flood control, shoreline protection, etc.) as well as new (e.g., waste water management) programs.

While the Corps will continue to be called upon to build or enlarge recreation facilities to meet the increasing needs of a growing population, particularly the urban segment, there will be a growing demand for higher quality, greater variety and a greater degree of consistency with the aims and values of the local people in the field of recreation planning. It is important that Corps economists and planners develop improved techniques for evaluating Corps recreation projects so that they will be more responsive to changing needs.

Some of the problems and issues which are appropriate for future IWR research will be discussed here.

II. Corps Research Program on Recreation

The Corps of Engineers began its research program in 1965 when the Director of Civil Works authorized studies to develop methods for conducting recreation use surveys and for measuring recreation benefits. The studies were conducted by the Sacramento District with the assistance of several consultants. Results of the research were presented in one contract report (Analysis of Recreation Use of Selected Reservoirs in California, 1965) and three technical reports (two published and one in draft form).

Technical Report No. 1 deals with survey procedures, No. 2 presents a model for estimating initial day use of proposed reservoirs based on similarity of project conditions, and No. 3 develops two regional day use estimating models from data collected at 19 Corps reservoirs in the Fort Worth and Sacramento Districts. Technical Report No. 3 also presents a model for estimating recreation benefits using variable travel costs as a proxy for price.

IWR involvement in recreation research has been minimal since its inception. IWR has given consultant support to the Sacramento District in its research effort. The only output of IWR research program on recreation to date is the state-of-the-art review of the economics of water-oriented outdoor recreation written by Professor Robert E. Kalter under IWR sponsorship (IWR Report 71-8). Kalter provides a rather comprehensive review of the literature, outlines the variety of methods used in recreation analysis, and suggests some ideas for further research.

Since the research and data collection program at the Sacramento District is essentially completed and in light of Dr. Kalter's state-of-the-art review, now is the time to outline some of the major topics which should be included in future research.

There are three related topics which need further study: the analytical framework, the data system, and policy issues. These three topics are interrelated: the analytical framework determines and in some degree is determined by the type and the availability of data; it provides guidance for decision making. A clear delineation of the policy issues will enable the researcher to plan his strategy and to make his research effort more relevant to needs.

III. The Analytical Framework

The analytical framework used most frequently in recreation analysis is the travel-cost model developed by Clawson and Knetsch. The model simply states that the value or benefit derived from a recreation experience must be necessarily equal to the amount of money the recreationist is willing to pay for such experience than without it. Since the recreation facility or resource is localized and immobile, the costs of traveling to the facility vary with distances. By observing the number of visotors and the amount they spend on travel, a demand schedule can be constructed displaying how the quantity demanded changes with travel costs. The benefits attributable to the facility may be approximated from areas under the demand curve.

The same principle is employed in the analytical framework in the Water Resources Council's proposed principles and standards for measuring recreation benefits except variable travel costs (costs for

miles driven) are used in the WRC model rather than total costs.

The approach employed in the Technical Reports No. 2 and 3 by the Sacramento District is also identical in principle with the Clawson formulation.

Critique of the Travel-cost Model: As admitted by the authors of the travel-cost model, Clawson and Knetsch, the travel-cost model tends to understate the benefits because the model does not provide simultaneous evaluation of the effect of time, travel (or degree of comfort) which cannot be evaluated in monetary terms. In addition, the formulation ignores the influence from competing recreation facilities.

One important criticism of the travel-cost model is then, since the demand schedule is constructed from observations of a particular site which is already built, it may not be applicable to a proposed site where the recreation facility is non-existent. Thus, considerable judgement must be used in evaluating the similarity between the existing and the proposed sites. The critics contend that it is almost impossible to separate the influence which the availability of supply may have on the use figures. This leads to the suggestion that maybe the researcher ought to investigate some of the fundamental forces or the causal factors influencing recreation choices such as leisure time, preference, technology, etc. without regard to specific sites.

Alternative Approaches: As stated in the WRC proposed principles and standards, alternative approaches to the estimation of the demand and determination of the benefits of a recreation plan are possible although WRC does not enumerate such alternatives. These would include

such techniques as simple trend projection over time, extension of trends in causal forces and application of the satiety principle. The usefulness of these alternatives should be investigated and may be used as a check against the results from the travel-cost model if such model is used as the principal analytical tool.

Market-oriented Approach: The Clawson formulation is essentially based on observations of use of a site by visitors originating from various distances. It fails to give full recognition to the value of the site destroyed by reservoir construction and to the demand offered by such a site. A market-oriented approach towards the identification of various markets for recreation, the substitution between alternative activities and sites which would maximize public benefits over cost is needed. Such a strategy could in the long run cut study costs, minimize the double counting of potential recreation across several projects and force the attention of the decision maker on all available recreation alternatives including those provided by other public agencies and private concerns.

The linear programming technique proposed by Professor Kalter in his paper (IWR Report 71-8) appears to be a useful tool for the market-oriented approach. The programming model is said to be able to handle "simultaneously projected demand by occasion type, capacities of visitation areas, and time, distance and cost constraints." Recreation planning is being treated as a spatial allocation problem.

The discriminant analysis techniques currently used in IWR navigation demand studies would also be appropriate for recreation research.

Recreation Analysis in the Context of Comprehensive Planning: It is significant to note that in its proposed Principles and Standards, the WRC does not recommend any one methodology for the evaluation of recreation use and benefits. Instead, it suggests several alternatives with the remarks that these alternatives are of an interim nature pending the development of improved methodology. When one carefully reads through Dr. Kalter's rather comprehensive state-of-the-art review, one cannot help but get the feeling that recreation research is still in its infancy and that all the existing methods are imperfect in some respects. They are either conceptually defective or are inadequate for implementation. While innovative research is needed, the economist perhaps can contribute to the pressing problem of evaluation in the interim by applying some of the basic principles of comprehensive planning. This would mean that the economist will have to examine any plan in the context of comprehensive planning for a community or a region. He would have to go beyond the benefits-cost analysis to evaluate all possible alternatives best suited to the people and the community. He would have to study not only the recreation supply and demand per se, but evaluate the recreation plan as one element of a larger master plan including plans for urban development, utility expansion, transportation, school, sanitation and other functions. The ultimate pay-off of this approach would be greater than concentrating exclusively on the economic issues.

IV. The Data System for Recreation Analysis

An analytical model is useless unless it is built on adequate and observable data. Likewise, policy decisions cannot be made in a vacuum. They must be based on facts. Over the past five years, the Sacramento

District has collected massive information on visits to Corps reservoirs. Unfortunately the information collected has only limited usefulness since it does not contain data on the social and economic characteristics of the visitors. Such data are vitally important for economic analysis and for policy studies. Day use information collected so far is not in sufficient detail to permit analysis of types of use such as fishing, hunting, boating, swimming, etc. The survey questionnaire should be redesigned.

The project or reservoir manager can be an important source of information and should be utilized fully in collecting and evaluating survey data.

Recreation data collected in recent past by the Forest Service and the Bureau of Fish and Wildlife may prove to be useful to the Corps.

V. Research in Policy Issues

Economists ought to be involved in the study of policy issues in recreation planning. This will benefit the management as well as the economist. The management will have the benefit of the economist in giving full consideration of the alternatives in problem solving. The economist will, in turn, by studying the policy issues, have better sense of real issues and become more pragmatic in his approach. This is true in other fields of research, but is particularly important in recreation research since this is a new and complex research area.

The overall objective of research in policy issues is to define the role of the Corps of Engineers in recreation planning, construction and operation and examine what is needed in terms of guidelines, organization

and procedures in order to fulfill such defined role. For instance, how can the Corps recreation plans be best integrated with those of other governments at various levels and with those of the local communities? If the Corps plan is not consistent with the values and goals of the local population, such a plan will likely fail.

A second policy issue which can be a worthwhile research topic is the problem of meeting the recreation needs of urban population. Should the Corps play an expanded role and provide non-reservoir recreation facilities, particularly when the latter are more viable?

A third issue is the land acquisition policy of the Corps. Without gaining access to the areas immediately adjacent to the shorelines and beaches, many of the Corps shoreline protection and beach erosion projects benefit only a few although the costs are borne mainly by the general public.

Last but not the least on the list of topics for research is the determination of a cost sharing policy which will meet the test of efficiency and equity.

DISCUSSION LEADER: James Tang

Concluding Remarks to Economists at Galveston — Col Robert R. Werner

I hope you have enjoyed yourselves. You certainly won't get credit from those back in the District offices for working while you were here. But whether this is considered a junket or a spiritual retreat, or intellectual reinforcement, or self-renewal, or merely an exchange of ideas, I am convinced your seminar here has been worthwhile. I do have some thoughts I would like to pass on to you, but I do not intend to summarize our seminar. Thank you all for coming here. Thank you particularly for stimulating our thinking--and when I say "our," I mean IWR, BERH, and OCE. We need your feedback, and regularly, to do the job we need to do. Speaking of jobs, let me comment on the functions of certain parts of our organization.

First, IWR. It is not, as some people alluded to it, an ivory tower. It is more a half-way house. Half way between the academic community and OCE. It is supposed to have one foot in reality and know what the problems are, and one foot in the academic world to know what the state-of-the-art is. IWR's job is to communicate to the academic world our needs and, taking the solutions that may be suggested from the academic world, translate these into help for the Corps both at OCE and in the field. It obviously is a difficult job to do.

Some comments were made about guidance from OCE. One way we develop guidance in OCE is by an Engineer Regulation. Engineer Regulations are usually a long time in preparation and quite properly so, because what we attempt to put out in a regulation is something that will govern the actions of 38 Districts and some 28,000 employees. When you do something like that,

you want to make sure that what you are saying is broad and applicable, and that what you receive is what you really wanted to get. It obviously takes time to do something of this sort. We also put out guidance from OCE on specific actions. We do this very infrequently, using hypothetical cases. More frequently we do it when we are asked a specific question on a specific project. BERH clarifies policy also in the same manner. When a project gets before the Board, they make comments on it, and either send it forward or send it back. If you feel you have something that needs to be done, or something that has to be reacted to, convince the people that you are working for and let it get responded to up the line.

I guess I should say something about the function of the field. That's fairly obvious that is where we do the work--that's where the payoff is.

What about the economist? Since I'm talking to economists, I can say that you're too modest. You play a very essential role--but I'll get back to that.

Planning is complex and requires a team effort and the economist is an essential part of the team. The objectives that we are working with are not economic objectives although they seem to be at times; all our objectives are social. This was true even when economists were first brought in and we were concerned primarily with national economic development. Our job is to manage scarcity. To do this we must place values on factors. There are new factors: Environment and social effects that we are dealing with now. In these cases the market gives poor readings. We have the problem of trying to connect the real world with the world as it should be. The economist has an important role as an interpreter there. Particularly because as a nation, we have not understood this until recently. We have a growth syndrome. Perhaps

this is changing. There appear to be new values now. Economists must help in finding these new values.

We have problems of assessment--identifying impacts--evaluating impacts--evaluating equity.

And with it all, the problem is communication. With a team effort, communication is a particularly acute problem. We have a collection of sociologists, engineers, economists--who assigns the values? Who can translate the values into terms that the others can understand? We have been talking during the conference about water quality problems. How many of you know exactly what the engineers are doing about this water quality business? You had best know what the engineers are doing and thinking. Neither the economists nor the ecologists can run around in little worlds of their own, working at their problems. If we run into environmental value traps--face it--it's your fault. You have failed us in translating an environmental value into something that the engineers can understand. George Antle spoke of the problems of interpreting needs and demands. Remember there are also desires--and it is up to you to sort these out and keep our thinking straight. The problem of the future is not the simple one it was once when we took a single projection and based our calculations on that. We are dealing with many alternatives and many alternative futures. I commend the book, "Limits to Growth" to you to give you an idea of how, by changing certain assumptions, we can change the future radically. I might add, that while it gives a rather discouraging picture of the future, it might be worthwhile reading the recent special section in The Economist in which the prospects for a viable future for Great Britain and the world were rather nicely developed. In any event,

all I am doing is underlining the complexity of planning and the need for you to participate.

This group can understand perhaps better than any what I mean when I say that within our organization changes must be made at the margin. We have many restraints: institutional, legal, budget. We can expect no radical changes in direction. We cannot get too discouraged at obstacles but we must try to keep moving in the proper direction, working within the system.

Two last points. Many thanks to IWR for initiating and arranging this conference; to the Galveston District for the support; to our consultants for coming, and for all who participated.

Lastly, be proud of the organization you are part of. Be practical in the solutions you come up with, and be professional.

Thank you.

SECTION II

WORKSHOP DISCUSSION SUMMARIES

Workshop on Navigation and Port Development
Deep Draft Ports

The workshop on deep-draft ports concerned generally (a) SPD experience with deep port studies, (b) general discussions, (c) the tentative FY 1973 IWR research program on deep harbors, and (d) additional researchable deep harbor problems having a potential for inclusion in the IWR FY 1973 program.

Mr. Yep described SPD experiences on deep harbor studies. Of the four U.S. deep harbor studies underway, two are in the South Pacific Division. These are the San Francisco Bay area study and the Long Beach-Los Angeles port study. The other U.S. deep port studies now underway are the North Atlantic study and the Gulf of Mexico study. Of all the studies, the one on San Francisco Bay area is the most advanced because of the time and money already spent on it, and it might serve as a model for the other studies. It will be a multiagency effort, and it will have an advisory group to oversee the entire study.

The San Francisco Bay area study has been divided into six work areas: (a) commodity flow studies, (b) vessels and port facilities, (c) transportation system analyses, (d) environmental analyses, (e) social well-being studies, and (f) national defense and security. The objective of the study is to produce a series of alternative navigation development plans similar to master plans. These would cover the range from projects desirable mainly from the economic point of view to those desirable from the environmental point of view. Local interests are opposed to any study which would set any future port development policy.

The San Francisco study was estimated to cost $4.5 million and to take five years to accomplish. Two years have already passed, and $230,000 was spent to produce a detailed plan for study. FY 1973 and 1974 were planned as the years in which most of the study effort would be accomplished. A $1.4 million effort was planned for FY 1973, but the Federal budget for that year includes only $200,000. The study will have to be rescoped to account for the current budget.

The commodity flow study is of major concern to economists, and it would be based on an economic analysis of all factors affecting waterborne trade in the San Francisco area. The effort would produce bracketing ranges of future trade which would then be evaluated to identify the social, environmental and economic effects on the bay region. The commodity flow studies would encompass the entire U.S. Pacific basin, and would cover such items as oil from the North Slope of Alaska, and trade with China and Japan. (A major conference on China trade will be held on the west coast in the middle of June.)

A subcommittee of economists has been organized for performing the commodity flow studies. Unfortunately, only the Corps and Mar Ad have major capabilities in the economic field in question. The study is being delayed because only $15,000 will be available in FY 1973 instead of the originally planned $485,000. The former amount is not enough to pay for a man-year of effort. An economic advisory board has been organized to oversee the effort of the subcommittee. Of the five men on the board, three are from industry and two from the academic world.

The commodity flow study would start with a review of previous studies. The Nathan study would be particularly useful in this respect.

It was noted that on the Pacific coast, petroleum does not move to and from public ports, but from privately developed terminals. Some 40 of these terminals exist on the coast. The commodity flow study will also examine methods with the objective of picking one best suited to the Pacific Coast needs. The methods examined to date all have deficiencies of some sort. The selected method hopefully would be adequate to update projected commodity flows periodically after completion of the current study.

The U.S. oil import problem was discussed at some length. A large range of options in this regard are open to the United States and these options would determine to a large extent how much crude oil would be imported into the United States in the future. It appeared that the present oil quota system would break down in face of already growing economic pressures. It was not known what the future U.S. oil import policy would be, however, it appeared that the probable range of policy decisions would leave the U.S. largely dependent on Middle East oil, and that terminals for large tankers would be required in any case.

The general discussions disclosed the following problem areas in the deep-port field:

a. How should local interest estimates of future traffic in port areas be evaluated?

b. How could the value of a turning basin be determined?

c. How are the land speed, ship size, and channel depth and width related? (The "Interoceanic Canal Studies, 1970" had some work in this field. Also, a procedure used by the Dutch was cited which minimized

the combined cost of navigation aids and channel dredging while providing for safe navigation.)

d. What determines the transit capacity of one-way and 2-way channels? (The 1970 canal studies referred to above have some work in this field.)

e. What navigation regulations should be adopted to insure capacity use of one-way and two-way channels?

f. What effect do navigation regulations as in (e) above have on shippers?

g. How should adequate attention be drawn to the strong economic pressures for large-scale industrialization which will prevail in areas near terminals for very large bulk cargo carriers? Experience has indicated that strict regulation is required if it is desired to restrict the deep port area to solely the transfer function as at Bantry Bay.

h. How might the environmental issues in the deep port field be quantified? (Some basic work in this field has been accomplished as at a seminar at Harvard held last fall. What remained to be done was to pull all the work together and to define the issues.)

i. What are the national defense and national security aspects of harbor facilities for very large bulk cargo carriers?

j. What are the balance of payments implications of the future import of very large amounts of petroleum into the United States? (SPD is aware of two efforts now underway which might be adapted for determining the balance of payment implications.)

k. What numerical relations exist between cargo short or long tons, cubic tons, Panama Canal tons, and revenue tons?

1. What family of ships will call on a particular future port? (It was suggested at the workshop that this question could be answered by projecting the commodity flow from the port, evaluating the origins and destinations of the trade, and then determining the sizes of ships most attractive to shippers for this trade. The depths of harbors at both ends of the route have a bearing on the solution. This problem cannot be solved by reference to the future world fleet since it is trade-route oriented. The solution for the tanker problem is inherent in the proposed petroleum system model to be described later. The solution is applicable, but much more difficult for trades using dry bulkers, and break-bulk carriers. The trade projections should apply specifically to the port in question. For example, the Dunkirk harbor is being planned to accommodate 300,000 dwt dry bulkers bringing in bauxite. Harbors for this trade on the U.S. gulf coast need not accommodate such large ships because U.S. sources for bauxite are relatively near and large ships offer very little economic advantage. The same procedure can be applied to areas where no trade exists as yet. An example is Alaska.)

m. What are the operating costs of various kinds and types of ships? (District representatives felt that the small amount of data available to them from reluctant industry representatives would give biased results.)

n. How can port capacity in terms of annual cargo tonnage or the number of ships accommodated annually be determined?

The tentative IWR program for FY 1973 was discussed. Individual program items followed by a digest of the workshop discussion are given in the following subparagraphs:

a. Assist CEQ by funding and administering contracts for evaluating oil-spill and non-oil spill environmental effects at two locations in the Gulf of Mexico. Very little comment was directed to this proposal. None of it was adverse.

b. Model the national petroleum system with emphasis on the harbor-ship combination including consideration of shallow draft ships. Numerous favorable comments were received on this proposal, and no adverse ones. An SPD representative offered to secure petroleum system studies from west coast industry representatives, if possible, and to send them to IWR for use as input for the IWR system study. A study of similar scope had been found useful in planning a system for northern France and other near-by European countries.

c. Research institutional aspects of ports for very large bulk cargo carriers. This would include consideration of legal, financial, and managerial aspects as well as wide participation on the local, regional and national level. This proposal received numerous favorable reactions, and no adverse ones. Some field representatives said that the institutional aspect of the deep port problem was one of the largest unknowns as far as the districts were concerned.

d. Determine the future effects on existing ports induced by development of regional facilities for large bulk cargo carriers at other locations. This potential study area received more comment than any other study proposal. All the comments were favorable. Apparently the effect with which the potential study is concerned was foremost in the minds of many field representatives. A representative of a consulting firm felt that the study should consider potential compensation for harbors not

deepened, and identification of other options open to those ports. The latter aspect might call for studies to determine the niche each port might occupy in the future economic scheme. The role of competition between ports should be evaluated.

e. Describe in a general manner the harbor and cargo handling facilities for terminals for very large bulk cargo carriers with emphasis on the interrelationships which define good port configuration, and including consideration of port needs for multi-purpose ships. This item received few comments, but all of them were favorable. A representative of a consulting firm felt that a report on this subject could be prepared which would be useful to the districts.

The workshop discussions were reviewed with the objective of identifying additional concepts which might be researched by IWR during FY 1973. The potential research items are described in the following subparagraphs:

a. Evaluate methods by which environmental effects of deep harbors might be quantified.

b. Define general methods for estimating port capacity.

c. Define general methods for determining the transit capacity of various kinds of navigation channels including defining the navigation regulations necessary to achieve maximum capacity. Consider also effects of the regulations on the shippers.

d. Research construction and operating costs of dry bulk and break-bulk carriers well enough to produce an authoritative set of values for use in navigation improvement studies.

e. Define the general method for estimating the future size distribution of dry bulk ships and break-bulk carriers calling at a particular port.

Discussion Leader: George Makela

WORKSHOP ON INLAND WATERWAYS NAVIGATION

John Norris of the Office of Facilitation of the U. S. Department of Transportation, Washington, D. C. was a guest of the Navigation Workshop. In introductory remarks, he outlined the role of all elements of the Nation's transportation network. He noted that new developments such as LASH and SEABEE with their barges aboard an ocean-going ship would undoubtedly open up new traffic for the inland waterways. He indicated his interest in the proposed joint DOT-IWR research study of coordinated movement of barge and other modes of transportation.

In the workshop devoted to navigation on the inland waterways the following major problem areas were cited by Corps economists:

North Central Division - Robert A. MacLauchlin reported that the Pennsylvania State University (PSU) inland waterway simulation model is now operational at the Waterways Experimental Station. This model was developed by PSU under contract with NCD and the St. Louis District of LMVD. The model's first application involved a 10-lock subsystem on Illinois River's 7 locks and the related three locks (25, 26 & 27) on the Mississippi River. NCD has applied the model to the entire Upper Mississippi River from the Minneapolis-St. Paul area to the St. Louis area. A paper by Joseph Carroll of PSU summarizing the model is published as a contributed paper.

Mr. MacLauchlin listed the following as two major problems:

a. Modal split of traffic to determine the total traffic for barge as part of the traffic by all modes of transportation.

b. The allocation of benefits created by improvements. These benefits

may be evaluated in terms of a specific project or in terms of an entire navigation system.

St. Louis District - Ronald Roberts reported that the St. Louis District needs a method to determine benefits from inland port development.

Memphis District - Norman P. Swenson noted the problem of evaluating inland port development, including the measurement of the physical and economic capacity of an inland harbor. A paper by Swenson regarding the Memphis Harbor is included as a contributed paper.

Vicksburg District - William Hobgood discussed the problem of harbor development including the determination of waterfront needs for industry - on the river and behind the riverfront.

New Orleans District - Everett Johnson noted the problem of adapting the PSU model to the Gulf-Intracoastal Waterway (GIWW).

LMVD - Homer Gardner stated the OMVD problem and opportunity of adapting the PSU model to the GIWW. Also noted was the need for timely guidance in the evaluation procedures.

Chicago District - Arlene Dietz listed the following problems:

a. Development of a model for fleeting areas for barges as a sub-system of a larger model. This is being accomplished by the District.

b. The application of subsystem models to inland waterway harbors.

Galveston District - W. H. Eldridge listed Galveston District problems as:

a. Modal split of traffic.

b. Evaluation of turning basin benefits.

c. Operating characteristics and efficiency of ships in restricted channels.

Summary - The major problems presented may be summarized as follows:

a. Modal split of traffic.

b. Allocation of benefits resulting from improvements.

c. Determination of benefits from (1) harbor development, (2) turning basins, and (3) fleeting areas.

d. Application of the PSU model to the GIWW.

e. Operating characteristics and efficiency of ships in restricted channels.

Item a will be included in proposed IWR research as a joint IWR-DOT project in FY 73. Items b & c will be discussed by IWR with OCE, BERH and field personnel for possible future research. Items d and e are being investigated by District and Division offices.

DISCUSSION LEADER: Howard Olson

WORKSHOP DISCUSSION: RESEARCH IN RECREATION

(See also Comments by Dr. Merewitz)

It was recognized by the workshop participants that research in outdoor recreation by Federal agencies has not kept pace with the ever-increasing demand for recreation. Thus, research in the economics of outdoor recreation represents an important area where the economists can make a significant contribution. Judging from the workshop attendance and discussion, it is apparent that Corps economists have not taken an active part in recreation planning at the field level. Hope was expressed that IWR research will, by improving the knowledge in this area, help the economists to play a more active role in recreation planning.

It was generally agreed that the Corps should take the lead in planning a research program in outdoor recreation. IWR will make the initial contacts and coordinate with responsible officials at Interior and other agencies. The possibility of funding from National Science Foundation and from the various agencies at Interior will be explored.

The workshop recognized the merits of some of the works completed at the Sacramento District. However, it was recognized that the "similar project" approach is conceptually deficient and is also costly.

The need for a market type of demand analysis was discussed but no conclusion was reached. Ideally a nation-wide survey of recreation demand similar to the one conducted by BOR but with certain improvements would be very useful but the cost of such a survey is beyond IWR capability.

It was pointed out that while demand estimate and benefit evaluation are difficult to make, the social cost of providing recreation opportunities such as the value foregone from damming a wild river is also extremely difficult to evaluate. The willingness to pay principle is not applicable here in the case of a free flowing river.

One area suggested for future research related to urban recreation needs and the Corps' role in meeting such needs. Another area for research relates to the economics of supply. Research is needed to explore those situations where the capacity and quality of the recreation facilities can be substantially improved with small increments to the existing investment.

Arlene L. Dietz of the Chicago District presented a paper, "Systems Analysis of Recreational Boating Activities on Lake Michigan". Her imaginative research methods as outlined in the paper, seeking to solve the interrelated problems of site location, facility mixes and development sequences for small boat facilities along the shore of Lake Michigan may have application in other districts having similar problems. See appendix for details of the research project.

DISCUSSION LEADER: James Tang

WORKSHOP ON MULTI-OBJECTIVE PLANNING

The workshop ranged over the issues related to the Corps of Engineers entry into multi-objective planning indicated by the proposed Water Resource Council's "Procedures and Standards for Water and Related Land Resource Planning," and the requirements imposed in Section 122 of the 1970 Flood Control Act. It was observed that multi-objectives actually formalize the important role that non-efficiency objectives have always played in Federal water resource programs.

The controversy evident in the public and private discussions of water resource development tend to concentrate on two important aspects. One is the conflict over values, goals and priorities of the society. This conflict is eternal but has intensified in recent years leading to shifts in the political appeal of resource development programs and open conflicts over the direction which the programs should take. The second important aspect deals with the appropriate role for Federal water resource programs to take in meeting society's goals and objectives.

A not unimportant aspect of the debate is the "how to" part of the problem. How can Corps of Engineers planners sense the public weal and determine relevant needs for water resources development? How can they identify relevant alternatives for meeting the needs? How can they quantify impacts across multiple objectives, for which value is an inherent source of conflict? How can planners communicate to decision makers (ultimately the

public) the consequences of relevant alternatives and receive approval or disapproval in a timely manner? Finally, how can Corps of Engineers economists efficiently contribute in the resolution of these issues?

While economists are uncomfortable with non-efficiency objectives and generally reluctant to engage in normative analyses, the real skills of the economist in sensing the plausible topology (see Boulding, 1958) of the response surface resulting from potential actions can contribute substantially toward the understanding of the issues. It is in this sense that a number of suggestions were raised which could lead to a program of research and to policy recommendations which would assist the Corps of Engineers to be more effectively engaged in the simultaneous and explicit evaluation of environmental, equity and efficiency issues. This would lead to projects and programs which generally enhance social well being in its broadest sense. In general, the following appear to be fruitful areas for economic research:

(1) Indicators of well being, especially improvement in the economic indicators of well being. Differentials in average per capita incomes between various regions do not adequately indicate the differences in well being. Variance in the cost of living and in life styles may lead to the conclusion that rather wide variations in per capital personal income include similar levels of well being.

Another important dimension of the need for research in indicators of well being is the development of aggregate indicators which collapse efficiency, equity, and environmental

and social dimensions into a single metric in such a way as to enable the development of criteria of acceptability of project or program proposals.

(2) The development of multi-level and sequential decision models which can accommodate the pluralistic nature of our government and society. No single level holds absolute control over any decision or feels the total consequence of any decision. Therefore, the decision chain must be viewed as multi-leveled and sequential.

(3) Considerable effort should be expended in developing procedures by which field offices can sense the relevant needs for water resources development in terms of the multiple objectives of society. This includes both the ability to quantify the objectives of water resource development and identify the portion of relevant needs appropriate to the Corps of Engineers program. With active use of such needs by Division and District Engineers to develop and manage their programs, the total Corps of Engineers program would be enhanced. Since the national economic development objective has been with us a long time and since it rests upon economic notions of market values in both the benefit and cost sense, early and active participation by economists in identifying those needs relevant to this objective should be of effective and natural interest to Corps of Engineers economists. If social, environmental, and the equity objectives embody the concept that the efficiency objective emphasizes biased market values, the correction of the biases can be handled in the context of trade-off analysis--another perspective which is

comfortable to economic analysis.

Considerable skepticism was advanced with respect to the efficacy of Federal water resources programs to meet social and environmental and equity objectives. This issue can be framed in its absolute sense or in concern for how water resource planners and economists can compare their programs to alternative programs which might prove more efficacious. Proper institutional settings must be developed in order that water projects oriented to the needs, for example, of people locked into structurally depressed communities, can be compared with strategies for improved mobility and other relevant strategies. On the other hand, if water projects can be designed which substantially impact on non-efficiency objectives of various communities, the information should be made available so that the opportunity will not be missed, and formulation tilted towards the perception and reactions to this sort of opportunity.

The bias of traditional planning for water resources is towards the supply side of the problem. Simply stated, the analysis starts from the proposition that we have a resource, a water resource--what can we do with it. Normally, what we can do is to control or alter the spatial or temporal distribution of the water resource. An overwhelming amount of current criticism is directed towards this notion. The alternative approach suggested is, we have a community of people. What are their real needs? How can the water resources be developed to meet these needs? This approach emphasizes the demand side of

the problem and reflects a considerable alternation in the philosophical perspective of water resource planners. Given careful study of the demand or needs by planners, performance criteria can be established for projects from which the range of technical alternatives can be arrayed and the balanced combination selected in such a way as to maximize community, regional and national well being.

DISCUSSION LEADER: Lloyd G. Antle

WORKSHOP ON WATER SUPPLY AND WATER QUALITY

Much work has been and is being done on the value of water in various uses. Not enough of this has found its way into actual use in the calculation of benefits of water supply. Very often the cost of developing alternative sources is the controlling factor in the cost allocation process. There are frequently no genuine single purpose alternatives to use in this comparison. Emphasis in the workshop was placed on the need to get true market values into the evaluation and cost allocation process. This is hard to do because the institutions which have developed trend to fix water in the bounds of traditional uses and make change difficult, costly and slow. The best known example is found in the use of water in agriculture, often in low value crops in areas where other uses are clearly able to pay more for this resource. It was recognized that the economist had a duty to work for a better understanding of the value of water in alternative uses and the economic and social benefits which would follow from a market oriented pricing of the resource, but it was also recognized that there were many complex questions involved here, such as the desire to maintain some farming in all states, desired distribution of population, etc.

The quality problem and its relation to the supply problems was discussed. Participants outlined some of the research undertaken in the Office of Saline Water to determine the cost of using low quality water in homes and industry. In homes the problem of water hardness and that of mineral content is not

adequately distinguished and this makes it difficult to make sense of some survey results. In industry this problem is not present. Nevertheless, the cost of using water of low quality has been more or less successfully demonstrated for both households and industry.

In connection with water quality it was observed that the Corps sells storage for water supply. It is the storage space that the states, cities and other water districts contract to buy in Corps projects. Thus, quality enters only indirectly into the transaction. But the question of quality is certainly becoming more important and the Corps is becoming involved in many ways, sometimes directly as when water users seek to get the Corps to take steps to alter quality, through engineering or management techniques. The Corps is experimenting with numerous techniques to alter water quality in Corps reserves both for use in the reservoir, as in recreation and for use downstream in domestic and industrial water supply systems.

The question was raised: "What is the quality of water in Corps reservoirs? Do we need to know more about it? Is this information available in any systematic form? Would a survey of this aspect for the reservoir program be desirable?" As far as was known, little systematic study has been made, but reference was made, as noted above, to the numerous requests for tests of the possibility of altering the quality. In the South Atlantic Division experimentation with pumping air through the water of the reservoir to prevent certain types of stratification had been attempted, with some success.

The Environmental Protection Agency needs much data on quality. They address numerous questions to the Corps for which there is no available answer. Many of these concern projected waste loadings by reach. Due to the many changes in EPA and in its predecessor agencies there have been numerous operational changes which have required much reworking of benefit estimates for low flow augmentation and other purposes. Water quality benefits are generally supplied by EPA. But this work has moved slowly. The workshop members recognized that EPA has a tremendous job to set realistic standards and that the effectiveness of these would take time to appraise. The EPA desire to get away as soon as possible from the need to store water for waste dilution was mentioned. Whether this can be done depends on the success of the enforcement program for clean up of water. It was observed that there are some opportunities to recapture cost or even to make profits from waste removal, as in the cheese industry, some steel making processes, in metal plating and in paper manufacture.

Discussion of the interface between supply and quality led to a brief discussion of how water supply storage was evaluated. It appears that there is considerable variation from District to District. Low flow augmentation may include a component for recreation, for fish and wild life, for dilution of polluted water and for land enhancement.

Following the discussion of the purposes for which water is stored in Corps reservoirs it was noted that there is a

growing need in some areas to reconsider the purposes for which storage was undertaken and perhaps reverse the purposes for which water is held. For example, some of the storage included in Corps reservoirs for water quality or for electric power may be demanded for supply. The Corps has been approached by several states and municipalities wishing to buy storage of this type. This situation may become commonplace. The question of whether storage which belongs to the general public should be sold for special uses or communities must be carefully considered. If the decision is made that the change in use is desirable there is still the question of the value of the water in the new use. In the cases discussed the states desired to buy at approximately the same cost at which their original water supply storage was acquired, although the market value today would be much greater. There are some important questions of equity here which the economist could help answer.

The discussion of the desires of states and municipalities to find more adequate supplies through use of storage set aside for quality control or other purposes such as power or recreation brought up the question of how decision is made on the amount of storage to put in Corps reservoirs. It was observed that in recent years many states are purchasing all the water supply storage which can physically be placed in Corps reservoirs. Examples of such purchases was mentioned in the corn belt states, in Tennessee and Kentucky, in North Carolina and in Texas. The

discussion developed that there were many reasons for doing this. Clearly, it would give the states a greater control over the water resource and some participants thought that this might suggest the future intent of the states to undertake regional water systems. Where municipalities and local water authorities purchase storage above apparent need, it has often been due to their belief that abundant water is a guarantee of economic growth or at least an important element in the ability to attract industry. In some cases where communities have assumed large contractual debts for water storage in Corps reservoirs the expected industrial users have not materialized and the payments for the unneeded water are a heavy burden and may lead to default. In other cases local water authorities have bought large quantities of water for fear that it may be moved into other areas for sale if local rights to it are not established. This appears to be the situation in parts of Texas. As noted earlier, the many institutions grown up around the water resource find it hard to adjust to changing economic needs. The role of water in determining or influencing economic growth and development is a matter of debate but that it is extremely hazardous to predict growth on the basis of the presence of this resource is certainly well known.

From the role of the states and municipalities, emphasis shifted to the numerous water distribution systems now being built in many parts of the U. S. to serve small towns, farm areas and many types of water users such as airports, golf

courses, hospitals, and many small industries. The districts usually pump from streams into their distribution systems. They are frequently not well engineered but they usually manage to keep customers supplied until drouth threatens their source of supply. Throughout much of the midwest, the east and the southeast a potentially dangerous situation is developing. In a drouth such as that of the 1930's in the midwest and of the 1950's in the southeast many severe water shortages will develop. The Corps would likely be called on to assist in such an emergency, which will be made worse by the fact that many private water systems are being allowed to deteriorate as more and more areas are covered by distribution systems, largely favored by the Federal Government. It was also pointed out that municipal systems in many cases are very wasteful, often wasting through leaks as much water as they deliver.

These discussions raised the question whether a survey is needed of the adequacy of supplies in streams where pumps have been established and in community systems. How could a standard of adequacy be developed? What standards of adequacy do we now have? A demand schedule would have to be developed. This would lead to need for estimates of drouths, their probability, etc. There was a question whether the research on drouth had reached useful conclusions. It was agreed that this might be worthwhile to explore.

With states, cities, and local distribution districts pressing for a greater share of the stored water supply, the

workshop participants wondered what the future of regional water plans would be. Few had yet seen the North Atlantic Water Supply Study parts of which have just become available.

It was pointed out that there were advantages and disadvantages to large regional systems. They might put water in higher uses but they also hold the potentiality of putting it in lower uses, and at great cost to the public. Poor regional water plans can lead to a truly disastrous use of resources. Some of the pros and cons of the California water plan were mentioned. The West Wide Water Plan was briefly mentioned as was the role of the Water Resource Council's National Assessment.

Future Steps: A Summary

1. Promote planning and evaluation studies in which the market price for water will have a chance to operate, bringing about a better allocation of the resource.

2. Repayment is based on cost and there is an urgent need to see that all costs are included. This is a need throughout the Corps. We would probably find that where costs are complete that the purchase of water supply in excess of need would decrease. Better costing would also help check the procedure of fixing water in traditional uses and in areas of origin, even where transport would place this resource in a higher use.

3. Work with EPA to clarify the relationship which exists between supply and quality, in relation to community water needs, and effectiveness of clean up plans and programs.

4. Promote studies which will add to our knowledge of the value of water of different quality for households and industry.

5. Begin investigations of equitable ways to move water in Corps reservoirs from one use to another in response to changing circumstances and values. This is a problem where rights and equity are involved and it should not be delayed until the demand for change is acute.

6. Consider the possibility of surveys to:

a. Determine the quality of water in Corps reservoirs and means of altering quality in responses to demands, including a study of who should share in the cost of such changes.

b. Determine the adequacy of water sources now being used by water districts, etc., with the aim of preventing a crisis during drouth through development of emergency plans and better sources.

c. In areas where water use is pressing close to the supply available, consider the possibility of studies of climate to see what warning could be devised.

7. The surveys mentioned in 6 above could lead to better definitions of the adequacy of water supplies and water qualities. Such standards should be developed and guidance on their consideration is needed throughout the nation.

8. River basin plans, state and regional water transfer plans, and such studies as the North Atlantic Water Supply Study and the National Assessment should be reviewed as closely related views of a common topic.

9. There is much knowledge available on the value of water in various uses. The political process does not find it easy to set up rules which allow the nation to take advantage of the savings economically sound water management would bring. Everything possible should be done to explore ways and means of bringing the water resource into the market economy where it can compete with other resources.

DISCUSSION LEADER: Robert W. Harrison

Report on Workshop
Flood Control and Flood Plain Management
Conference for Economists of the Corps of Engineers
22 - 24 March 1972

1. Purpose. The main purpose of this report is to present for the record the views of field personnel on research needs in the area of flood control.

2. Land Use. There was agreement that land use analysis would become increasingly important for Corps flood control evaluation, as evidenced by the INTASA simulation model, the Pullman Study, and the St. Louis SMSA study. The field personnel was concerned with the following issues: how much detail of land use and activity types is practical; how much is necessary; how can local plans be evaluated for reasonableness and consistency with OBERS data; if such local plans are not reasonable should the Corps "change" the plan; are there any reasonable "cut-off" years beyond which changes in land use should not be considered.

3. Future Depth-Value-Damage Relationships. Much of the discussion centered around the use of personal income to project future value of property, once land use is established. There was general agreement that changes in value and damages are not a simple relationship and should be approached in a broad socio-economic framework. The following issues were brought up: what indices are available for non-residential use; in what situations will personal income be a fairly good indicator; are there reasonable "cut-off" years available; is there anyway to obtain income levels for small areas (e.g. IRS data; OBE data); are there major shifts in expenditure patterns as income rises.

4. Existing Depth-Value-Damage Relationships. Several participants (but not all) expressed a need for existing depth-value-damage curves on a current up-dated basis for all activity types, based upon damage surveys by the various Corp Districts as well as other agencies. The thought was that by providing a clearing house of flood damage data that a major, time-consuming portion of the analysis could be greatly simplified.

5. Data Collection and Report Management. Many participants felt that data collection had gotten out of hand, in the flood control as well as other water resource fields. The field was interested in research on the question of which elements of flood control analysis are critical and which are (unnecessary and time consuming) refinements.

6. Miscellaneous. Several other problem areas were mentioned by at least one participant; discussion was minimal and no consensus was reached:

a. Inflation by area. Means of deriving price level changes by small area.

b. Surplus crops. Proper evaluation criteria in agricultural flood control.

c. Cost-sharing. Analysis of warping effects of current cost sharing policies.

d. Principles and Standards. Effect of multi-objective planning on flood control evaluation.

7. Comment of Discussion Leader. It is believed that the above summary reflects the basic problems facing Corps field economists. My major comment is that I was surprised that the field did not mention the integration of structural measures into a total flood plain management plan as a critical problem area. It would appear obvious that effective flood plain land use planning cannot take place without consideration of all

management alternatives (as discussed by Mr. Phippen in the General Session).

8. Presentation. The workshop wishes to thank the following persons who presented development in the flood control field

a. Paul Fredericks (Walla Walla District) for his presentation of flood plain management and public participation in Pullman, Washington.

b. Andre Corbeau (Consultant, U. of Missouri) and Ron Roberts (St. Louis District) for their presentation of the St. Louis SMSA study.

c. Bill Hearrean (Kansas City District) for his presentation on personal income.

Edward A. Cohn
Discussion Leader

WORKSHOP ON IMPACT OF WATER RESOURCES DEVELOPMENT

This workshop was oriented towards impact assessment, across the multiple objectives of water resources development. A good deal of the discussion was focused on assessment of completed projects. The status of the SWD-IWR study of the impacts of the completed McClellan-Kerr Arkansas River multiple purpose project were presented. Since the study is in its initial phases, most of the discussion dealt with the hypothesis for the study and the fundamental assumptions inherent in the research strategy.

A basic commitment to a procedure which would rely on projecting forward the kind of economic activity which would be affected by the project and then confirming the projections by experience was advanced. This requires a series of short run (5-10 years) projections, then testing against experience. Early effects are expected initially in changes in the transportation system. Therefore, early studies are concentrated upon understanding the relationship of the waterway to the other modes and to the response of transportation users to the presence of the new mode.

Much of the response to a public works project depends upon the ability of local, state and regional interests to organize to exploit the advantages presented by, in this case, a new transport mode and the resultant alterations in rate structure across the various modes. One of the early components of the

impact study will be an analysis of regional response through port development.

An annual report is contemplated, in which regional response with the project is documented and related to the output (flood control, recreational use, water supply, power, etc.) of the multiple purpose project. This document will also allow a summary of progress in other portions of the research.

Impact Assessment in Planning Studies.

A fundamental reason for studying the impacts of operating projects is to develop improved procedures for estimating the impacts of potential projects. Broader assessment and interrelation of economic with social, environmental and political impacts is envisioned.

Section 122 of the Flood Control Act of 1970 and the tentative "Principles and Standards for Planning Water and Related Land Resources" by the Water Resources Council reflect an interest by Congress and the Administration to encourage broader assessment of the impacts of potential projects and to encourage broader assessment of the impacts of potential projects and to formulate plans which satisfy a public desire to avoid or ameliorate undesirable effects and to attain the best mix of desirable effects.

Since Corps of Engineers procedures under Sec. 122 are in draft form and the Water Resources Council's "Principles and Standards" are undergoing changes resulting from public hearings, it was impossible to develop in detail the potential

requirements for Corps of Engineers planners. However, the general tone of potential guidelines was indicated. Gen. Cooper, Col. Werner, Jack Sheaffer, Jim Tozzi and Bill Donovan's remarks during the general session gave some indication of the direction the Corps would be moving in.

Conclusions.

The workshop session reached no conclusions either about the desirable direction for research to take or, in a more general sense, on the direction for Corps of Engineers procedures for impact assessment to take. This lack of consensus reflects in part the high degree of confusion within the water resources fraternity, about desirable modifications of benefit-cost analysis and about the need to enter the broadened analysis signaled by the provisions of Water Resources Council's "Principles and Standards" and by Sec. 122.

The traditional analysis offered some measure of discipline on the ranking of water resources projects for Federal funding. However, the effect of this discipline is obviously weak, in view of the 20 billion dollar backlog of authorized Corps of Engineers and Bureau of Reclamation projects. This huge backlog leads to a shift in control, in the sense of advancing projects for implementation, away from the authorization to the appropriation process. The appropriation process weights political equity (equalized expenditures across all regions) much heavier than efficiency

(the basis for evaluation in survey reports) and substitutes factors such as the status of proposed projects in relation to ongoing river basin development plans, presence of positive local and state government support into dominant position in the criteria for decision.

Thus, there is reason to question the direction for survey report analysis to take. Would it make any real difference if the stringency of economic efficiency criteria were relaxed? This could lead to a larger backlog. One major problem is to get the kind of projects into the backlog for which there is significant local and state support. The support can develop only if state and local interests can understand that the potential project meets their urgent needs and is integrated with ongoing activities of other Federal, state and local programs in a logical sequence. It is quite clear, that both proponents and opponents of Federal water resources programs desire a considerable change in the process by which projects are conceived and executed involving a considerable change in the types of projects and the desired outputs of optimal projects.

Many of the comments from the floor on the issues described above added up to another dimension worthy of mentioning. That dimension could be described as a perception by Corps Economists of the very limited role for economists in the planning process. Their role is limited to that of estimating impacts from a pre-selected course of action, with impacts narrowly defined in economic efficiency criteria. Comments on the role of

economists reflected upon the need for analysis of completed projects, since study could possibly indicate that some projects are not producing what was expected. Other comments reflected a lack of perception of the role that economists can play in ranking needs and determining the order of priority, to participate in determining those alternative courses of action which are viable solutions to an urgent problem, and to assist in developing strategies for implementation of effective solutions. It would seem that the responsibility for a broadened role for economists on the planning team lies both with economists and planning managers. A broadened role can be observed in some district offices and in various special study teams. It was recognized that this development should be encouraged but must be initiated by economists. They should develop a competence in and should be able to handle issues other than those concerning efficiency.

Finally, considerable effort should be initiated by economists to develop procedures for demonstrating the connection between efficiency, equity, environmental and political dimensions of planning problems. The integrative efforts which would reduce the burden on decision-makers in assimilating vast quantities of data and values in order to concentrate on the important options, the relevant tradeoffs and on the application of the concept of tradeoff to resolve conflicts are consistent with the body of economic thought and practice from the earliest days when the field was described as "political economy".

DISCUSSION LEADER: Lloyd G. Antle

SECTION III

CONTRIBUTED PAPERS

REMARKS BY WALTER YEP
AT THE CORPS OF ENGINEERS CONFERENCE OF ECONOMISTS
SESSION OF NAVIGATION AND PORT DEVELOPMENT
FLAGSHIP HOTEL, GALVESTON, TEXAS
23 March 1972

The South Pacific Division has two House Resolutions for comprehensive port studies. The first Congressional resolution is for the San Francisco Bay Area In-Depth Study under the San Francisco District (a copy of this resolution is attached as Exhibit I). The second resolution calls for a similar study in the Los Angeles-Long Beach area which is assigned to our Los Angeles District.

As you may know, the Corps nationwide has four comprehensive (or regional) port studies. In addition to the two in the South Pacific Division, the Lower Mississippi Valley Division is initiating a study for the Gulf Coast and the North Atlantic Division has a resolution for the North Atlantic ports. Of these four studies, the San Francisco Bay Area In-Depth Study is the most advanced. Obviously, it could serve as a model for the other regional port studies.

To better inform you about the In-Depth Study efforts, I have divided my remarks into two parts. The first part will be a general survey to familiarize you with the study. The second part will discuss one of the related sub-study, the Commodity Flow Analysis - the central theme of my remarks.

1/ Speaker is Chief, Economics Branch, South Pacific Division, 630 Sansome Street, San Francisco.

RESOLUTION

"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on San Francisco Bay and all tributary deep water ports, as contained in two resolutions adopted by the Committee on Public Works of the House and Senate (Resolutions authorizing Comprehensive Bay Survey and San Francisco-Sacramento-San Joaquin Delta Study); and Reports published in House and Senate Documents (San Francisco Harbor, Redwood City, Lower San Francisco Bay, Oakland Harbor, Richmond Harbor, San Pablo Bay and Mare Island Strait, Sacramento Deep Water Channel, Suisun Bay, San Joaquin River, Stockton Channel).

The investigation to be undertaken with the object of promoting and encouraging the efficient, economic, and logical development of the harbor complex and its hinterland. The scope will encompass investigation of current shipping problems, adequacy of facilities, delays in intermodal transfers, channel dimensions, storage locations, and capacities, and other physical aspects affecting Golden Gate waterborne commerce.

The investigation shall include, but not be limited to, the impact of waterborne commerce in the Golden Gate region on the local, national and international economies, and its relation thereto; research into current and future markets for the import and export commerce of the region; evaluation of regional Pacific Coast integrated approaches toward the opportunities and problems engendered thereby; an inventory of regional shipping facilities, capacity, and operating entities and an evaluation thereof; a study of industrial and trade trends owing to new and improved technological advances, methods, improved vessel design, cargo handling facilities, extension of automation, and other cargo, vessel and operating concepts; relationship of waterborne shipping to other modes of transportation with particular reference to intermodal transfer and facilitation of through-shipments; comparison of the status and future of Bay Region ports and terminals with other national and international harbor complexes; recommendations for types, sizes and locations of future facilities, and improvements and expansions of existing facilities, including deep-draft navigation channels; recommendations for improvements in harbor and industrial operations and development through improved coordination and programming, including solicitation, market research, public relations, advertising and long-term planning; determination of the adequacy of the region's shipping capacity in terms

EXHIBIT 1

of its role in the defense mobilization base, and citing any inadequacies therein; the role and functions of the harbor complex in Pacific Basin development; presentation of guidelines for regional development to the extent required by navigational uses and potentials; contributions possible on balance-of-payments through expanded commerce and more efficient harbor operations; determination of bulk movement projections, including estimated raw material requirements of the regional and national economy possible of shipment through the Golden Gate, with particular reference to economies afforded by use of super-sized bulk transport vessels and tankers; advantages afforded to the Government by waterborne commerce's contributions of increased tax revenues and improvements in balance-of-payments; effects on the regional and national economy of new and expanded heavy industry and ancillary industry and ancillary industries dependent thereon as a result of improved navigation and more efficient harbor operations; and desirability and extent of Federal participation in securing adequate bases for expansions and improvement of shipping facilities and further integration of regional planning for waterborne commerce."

The Resolution was sponsored by Congressmen Don H. Clausen, Jerome R. Waldie and Harold T. Johnson

Part I. The In-Depth Study.

To begin, the San Francisco In-Depth Study is a multi-agency, multi-discipline effort involving the engineering, physical, biological and social sciences. A Detailed Plan of Study has been prepared and reviewed by the House Committee on Appropriations. This Detailed Plan, dated 8 March 1971, sets forth the objective of the study, the areas to be investigated, the particular Federal agencies involved in the study, and the estimated time and costs required to complete the study.

With the Corps as lead agency, the overall study effort is being managed and coordinated by the Corps San Francisco District. A Special Regional Planning Division within the District has been established for this study under Colonel William E. Vandenberg. To assist in the conduct of the overall study, Col. Vandenberg has formed a high-level Advisory Committee. The members of this Advisory Committee are shown on Exhibit II.

Study Objective

The principal objective of the In-Depth Study is to prepare guidelines for alternative regional navigation plans to accommodate waterborne commerce in the San Francisco Bay Region. These guidelines will be prepared in the context of needs for environmental protection, enhancement and general community well-being. The output of the study will be a series of navigation development alternatives for different levels of commerce, together with their physical, economic, environmental and social implications. This array of alternatives will range from those favorable to the environment to those favorable to economic development of the Bay Region.

SAN FRANCISCO BAY AREA IN-DEPTH STUDY

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MARITIME TRADES PORT COUNCIL

EXHIBIT 2

Major Study Elements

To fulfill the study objective, six analyses are being commenced. They are:

1. Commodity Flow Analysis. This analysis will be discussed later. It is only important to note here that the commodity flow analysis permeates all aspects of the study, and the alternatives formulated will rely heavily on the data developed in this analysis.

2. Vessels and Port Facilities Analysis. This analysis will provide designs and cost estimates of navigation development alternatives phases of the study. Separate analyses will be made of vessel trends, navigation channels, and port facilities to accommodate projected levels of commerce, taking into account objectives and criteria established for the major study analyses. Potential independent or centralized docking facilities within the Bay Region will be considered. This sub-study will be co-managed by the Corps and the Maritime Administration.

3. Transportation Systems Analysis. This analysis will determine a series of integrated transportation systems (land and air) necessary to handle the levels of commerce of different navigation development alternatives, considering the needs of the environmental and community well-being objectives. Separate analyses will be made of the present and projected highway, air and pipeline transportation networks for their capacity to handle various commodity movements. This sub-study will be managed by the Coast Guard for the Department of Transportation.

4. Environmental Analysis. This analysis will formulate environmental principles to serve as guidelines for future developments in navigation within the Bay Region and potential adjacent coastal harbor

sites and will evaluate navigation for compatibility with these principles. Individual items of analysis will include existing and potential modification of the biota, hydrology, geology, physiography, soils and climate of the Bay Region under various alternative port systems. This sub-study will be managed by the Environmental Protection Agency.

5. Social Well-Being Analysis. This analysis will formulate social well-being principles to serve as guidelines for future developments in navigation within the Bay Region and will evaluate navigation alternatives for compatibility with these principles. Individual items of analysis will include economic factors (employment, population, income), general welfare factors (health and safety), and quality of human environment factors (open space, recreation, land use) associated with future navigation developments. It should be noted that the more traditional features of an economic base study are included. This sub-study will be managed by the Corps despite unsuccessful Corps efforts to have another agency such as HEW direct the analysis.

6. National Defense Analysis. This study will determine the relative role and requirements of the National defense aspects of the San Francisco Bay port system. This analysis will include the appraisal of the present and future capacities of port facilities, and the determination of optimum routing of traffic under different port system configurations as utilized for military purposes. This sub-study will be managed by the Corps.

Funding and Study Schedule

The In-Depth study is estimated to cost $4.5 million in addition to previous allocations of $230,000 prior to FY 1972. The corps has submitted a unified Federal budget request and will transfer allocated funds to other

participating Federal agencies involved in the sub-studies. The major study efforts will be conducted over the three-year period FY 1973 through FY 1975. However, these study efforts are now being reevaluated since the President's Budget (February 1972) calls for only $200,000 in FY 1973 instead of the requested $1,040,000. At this funding rate, the study will take 25 years to complete which would be unrealistic.

Part II. The Commodity Flow Analysis

With this general background, I shall turn to the Commodity Flow Analysis - one of the most comprehensive and challenging economic studies that I have encountered. To begin, I would like to explain what is meant by a commodity flow analysis and the need for it.

In the context of our port studies, it means an economic analysis of the trade factors affecting the movement of waterborne commerce. Once these factors are identified and their relationship to export, import, coastwise and internal traffic are analyzed, it is possible to estimate a range of potential commerce movements through a specific port system.

Without being too detailed, the elements which enter into a commodity flow analysis are the origin and destinations of traded goods, international trade propensities, national and regional growth, potential consumption patterns, competition between port systems, trade balances, technological efficiencies, and development of new import and export commodities, among others.

In terms of outcome, the commodity flow analysis will provide a range of potential waterborne commerce levels. Associated with each range will be an impact analysis on the economic structure of the Region. This knowledge

will be required by planners and decision-makers in considering future port facilities and improvements.

Study Scope

The commodity flow sub-study has the broadest scope of the In-Depth study covering the San Francisco Bay Region, West Coast, Pacific Basin and the World. It is this scope which brings the Economics Branch of the South Pacific Division into the study. The branch is the only Division element participating directly in the study and is responsible for the management of the commodity flow sub-study. With two regional port studies in the Division, it is anticipated that this one sub-study would serve both major studies.

The scope of the sub-study will be principally concerned with the existing and future commodity movements through the San Francisco Bay Region and its tributary areas. However, analysis of international and national maritime economics will be made to the extent necessary to substantiate regional estimates of potential waterborne commerce.

For instance, the long-term prospects of China trade and North Slope oil development would have a very obvious impact on West Coast ports, particularly port activities within the San Francisco Bay port system. So will future changes in our trading activities with Japan. Exhibit III will give you an idea of the magnitudes (tonnages) between West Coast ports and countries rimming the Pacific Basin.

Organization

In organizing for this sub-study, those Federal agencies expressing an interest in participating were contacted and invited to a meeting held on

U.S. WATERBORNE STATISTICS - CALENDAR YEAR 1970
(THOUSANDS OF SHORT TONS)
PACIFIC BASIN TO PACIFIC COAST*

TRADE AREA	EXPORTS	IMPORTS	TOTAL TONNAGE	% OF TOTAL
A. PACIFIC CANADA	1,099	5,088	6,187	10.5%
B. FAR EAST (NORTH) INCLUDES JAPAN	34,505	4,643	39,148	66.2%
C. FAR EAST (SOUTH) INCLUDES TAIWAN & PHILLIPINES	2,373	1,294	3,667	6.2%
D. MALAYSIA & INDONESIA	308	4,072	4,380	7.4%
E. AUSTRALIA	880	1,594	2,474	4.2%
F. WEST COAST SOUTH AMERICA	267	530	800	1.3%
G. WEST COAST CENTRAL AMERICA AND MEXICO	521	1,976	2,497	4.2%
			59,153	100.0%

*PACIFIC COAST INCLUDES ALL PORTS IN THE STATE OF HAWAII, CALIFORNIA, OREGON, WASHINGTON AND ALASKA

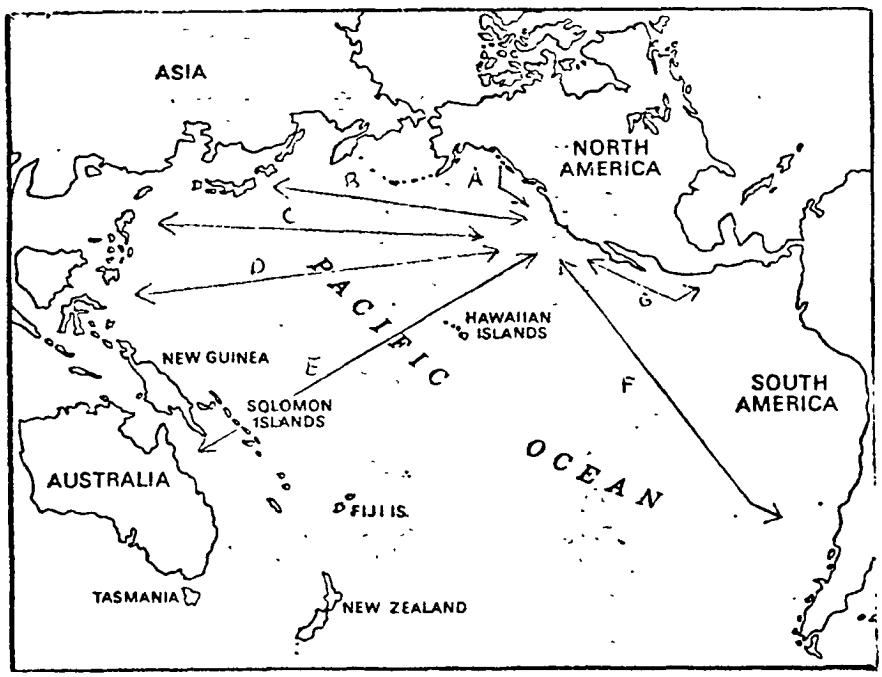

EXHIBIT 3

1 February 1972. The purpose of the meeting was to familiarize inter-agency representatives with the economic requirements of the In-Depth study and to obtain their views for conducting the analysis. The meeting was an ice-breaker since many of the agency participants were being involved in port studies for the first time. To increase their familiarity, plans were made for follow-up contacts and distribution of background information. In summing up this first meeting, it seems that the Corps and the Maritime Administration are the only experienced agencies in commercial navigation economics and waterborne commerce projections.

One obstacle to active participation is the fact that most agencies are not yet funded; accordingly, the Corps cannot expect a great deal of interagency involvement until funds are provided. For the time being, the plan is to hold periodic meetings to keep each agency representative informed. The next meeting is tentatively scheduled for 20 April 1972.

Agency representatives at the February meeting are listed on Exhibit IV. In addition to the agency listing, you should note the designation of an Economic Advisory Board also present at the February meeting.

This Economic Advisory Board has been organized to work closely with the interagency economists performing the commodity flow analysis. The members have diverse economic backgrounds and are expected to provide us with theoretical expertise as well as practical business knowledge. Messrs. Buell, Neumann, and Watterson are responsible for the economic activities within their respective firms and have been very important in providing us with the business economist's views. Dr. Tussing is an acknowledged expert

INTERAGENCY PARTICIPANTS, COMMODITY FLOW ANALYSIS

NAME	ADDRESS
MR. MARC C. IRISH	DEPT. OF NAVIGATION AND OCEAN DEVELOPMENT SACRAMENTO, CALIFORNIA
MR. A. JERRY JEREMY	U.S. DEPT. OF COMMERCE, BUSINESS SERVICE OFFICE SAN FRANCISCO, CALIFORNIA
MR. TED PLESSNER	U.S. DEPT. OF COMMERCE, MARITIME ADMINISTRATION SAN FRANCISCO, CALIFORNIA
MR. RAY LANIER	ECONOMIC RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE, BERKELEY, CALIFORNIA
MR. K. D. BARBER	U.S. BUREAU OF MINES, SPOKANE, WASHINGTON
MR. R. W. CORKREY	U.S. DEPT. OF COMMERCE, MARITIME ADMINISTRATION SAN FRANCISCO, CALIFORNIA
MR. JOHN W. PULLEN	U.S. DEPT. OF COMMERCE, MARITIME ADMINISTRATION SAN FRANCISCO, CALIFORNIA
MR. EDWARD N. SMITH	U.S. DEPT. OF LABOR, BUREAU OF LABOR STATISTICS SAN FRANCISCO, CALIFORNIA
MR. WALTER YEP	USA CORPS OF ENGINEERS, SOUTH PACIFIC DIVISION SAN FRANCISCO, CALIFORNIA

EXHIBIT 4

ECONOMIC ADVISORY GROUP

NAME	TITLE	ADDRESS
MR. WARREN BUELL	CHIEF ECONOMIST	UNION OIL COMPANY OF CALIF. LOS ANGELES, CALIFORNIA
MR. DON NEUMANN	CHIEF ECONOMIST	KAISER ENGINEERS OAKLAND, CALIFORNIA
MR. STU WATTERSON	ASSISTANT MANAGER ECONOMICS DEPARTMENT	STANDARD OIL OF CALIFORNIA SAN FRANCISCO, CALIFORNIA
DR. RONALD MCKINNON	SPECIALIST IN INTERNATIONAL TRADE	DEPARTMENT OF ECONOMICS STANFORD UNIVERSITY PALO ALTO, CALIFORNIA
DR. ARLON TUSSING	SENATE STAFF ECONOMIST	U. S. SENATE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS WASHINGTON, D. C.

on Alaskan oil and Japan trade. Dr. McKinnon is a highly regarded authority on international trade theory. Currently, there is a possibility of expanding the Economic Advisory Board with a "bank" economist and an "environmental" economist. However, I plan to be very selective about any new additions. New additions must be economists of recognized stature and be able to participate actively. With this cross-section of economic expertise, we look forward to some very robust work in our sub-study.

Current Work

During these early study stages, the Economics Branch is proceeding in accomplishing as much of the preparatory work as possible prior to the full commencement of the In-Depth Study.

In addition to organization, a great deal of effort has been placed on coordination. There is a great deal of in-house (Corps) coordination involved. Meetings have been held with our counterparts in the Corps North Pacific Division which covers the port activities in Oregon, Washington and Alaska. Our analysis will extend into their area. In the near future, the branch expects to work out coordination procedures with our Pacific Ocean Division in Hawaii covering their port activities and obtain their inputs.

For a national perspective, the branch has worked closely with our Washington, D. C. offices to be informed on their economic studies. The Center for Economic Studies has initiated several major studies which may influence our own efforts. One report, of course, is by Arthur D. Little, Inc. on "Foreign Deep Water Port Development." Two forthcoming studies are by Robert Nathan Associates on "Deepwater Ports of the United States" and by Professor Joseph Carrol, Pennsylvania State University on a methodological survey of "The State of the Arts" for long-range waterborne commerce projections. After meeting with the Nathan people and Professor Carrol and

reviewing drafts of their work, some savings in our own work will result from their efforts.

For more tangible accomplishments, the branch has either completed or is nearing completion the following:

a. Draft report on historical commodity movements in the San Francisco Bay Region (available for distribution).

b. Draft report on literature, relating to the analysis of commodity flows through West Coast Ports available in June 1972.

c. Draft report on preliminary projections of waterborne commerce for the San Francisco Bay Region available in June 1972.

d. Critical Path Network for commodity flow analysis.

The purpose of the report in item "a." was to update the data in the California Framework Study; to categorize the historic traffic movements by methods of cargo handling; and to indicate commodity origins and estimations on a port-to-port basis. The categorization of commodities by cargo handling methods is important since the projections will be made by the same categories of liquid bulk, dry bulk, special handling (containerized and LASH) and general cargo. Since this report, we have been requested to include revenue-tons and cubic tons by local port interests.

The literature search report in item "b." is essentially complete. The report has a methodological review of 15 major studies containing projections and lists approximately 100 reports pertaining to commodity flow analysis. The report is not yet available since another section covering the investigation of empirical data sources may be added to this report. It will be available by June.

The report on preliminary projections in item "c." is still undergoing revisions. Basically, the report collects and analyzes existing

projections that have been made for the San Francisco Bay Region. One of the more important comparisons made in the report is Exhibit V. As you can see there are wide variations in the estimation of future commerce for the bay region - a multiple difference of 3 times by year 2020. This report will be completed and available by June. There is a possibility that it may be combined into one report with item "a."

The last item "d." is the study design for the commodity flow analysis. This is the first approximation of a CPN. Additional refinements are needed. It will serve as a guide to our study efforts. Judging from past experiences, CPN's are subject to changing events and major modifications can occur by fiscal years. While it may not be precise, the essential work requirements are covered. I would appreciate any comments you may have on our study design which is shown as Exhibit VI. (Exhibit VI entitled Critical Path Network for Commodity Flod Analysis, San Francisco Bay Area Indepth Study is omitted here because of size limits. It may be obtained by writing to the author at SPD. Notes by IWR.)

Future Work

For the remainder of FY 72, we plan to complete the reports mentioned and continue work in the three major areas specified in the critical path network.

The first area is coordination of the In-Depth study with other regional port studies getting under way. The main point here is to be sure that the West Coast estimates of waterborne trade is consistent with their estimates and national totals. Also Corpswide agreements are needed for standardizing the grouping of commodities used in projections analysis. Secondly, we plan to make a detailed investigation of major data collection centers. The two principal centers are the Corps Waterborne Statistics Center which has the national responsibility for collecting domestic commerce data and the Bureau of the Census which collects foreign trade data. While there are other

PROJECTIONS BASED ON DATA AND RATES OF GROWTH SET FORTH IN FOLLOWING REPORTS:

- FRAMEWORK STUDIES, CAL REGION (BASE PLAN)
- US OCEANBORNE FOREIGN TRADE, MARAD TASK FORCE
- PORT OF SAN FRANCISCO, A.D. LITTLE CO.
- FORECASTS OF US OCEANBORNE FOREIGN TRADE, DRY BULK, BOOZ-ALLEN APPLIED RESEARCH
- OCEANBORNE SHIPPING, DEMAND & TECHNOLOGY, LITTONS SYSTEM
- INTEROCEANIC CANAL STUDIES, ATLANTIC-PACIFIC INTEROCEANIC CANAL STUDY COMMISSION
  - A - POTENTIAL TONNAGE
  - B - LOW RANGE OF TONNAGE
- PROJECTIONS OF PRINCIPAL US DRY BULK, STANFORD RESEARCH INSTITUTE

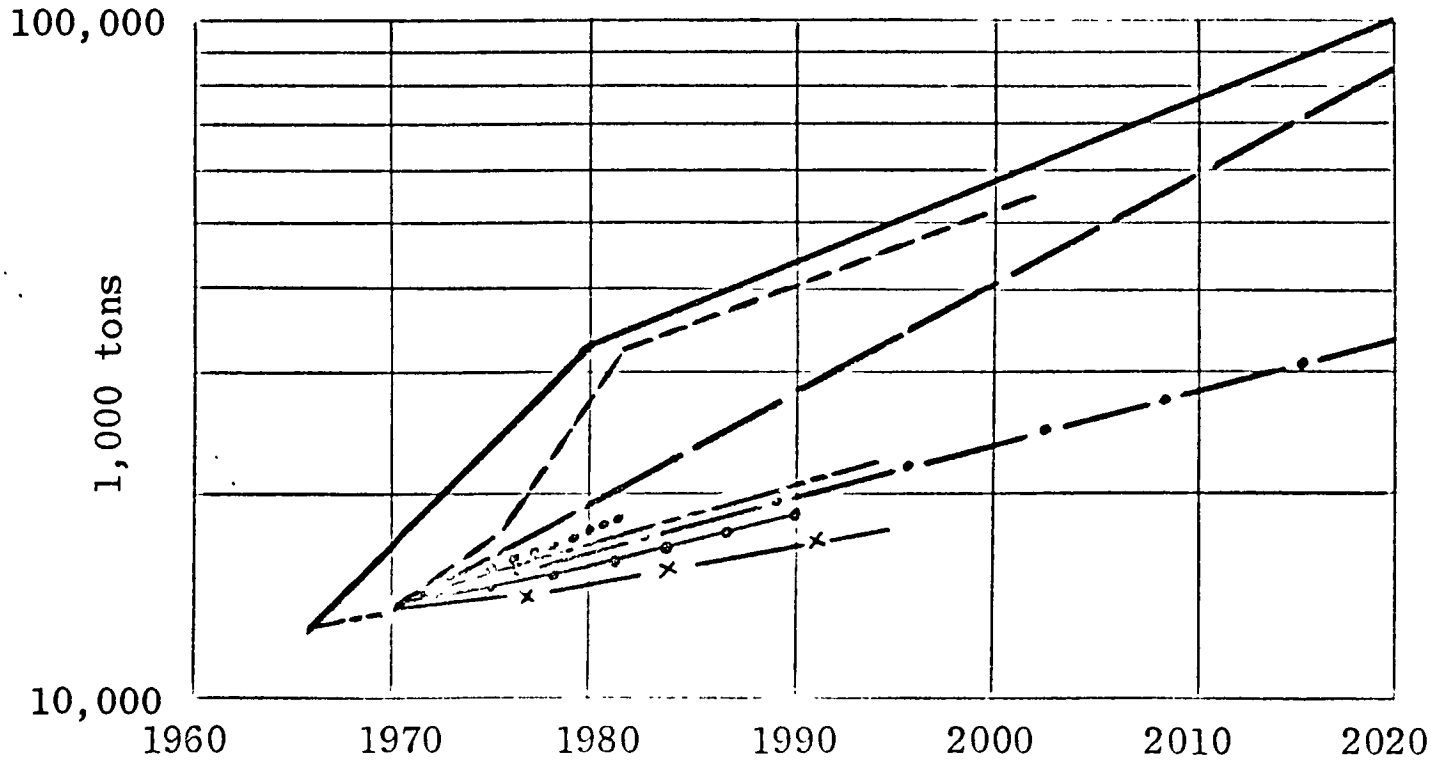

EXHIBIT 5

data sources, we plan to rely heavily on the cited source for our empirical work.

The final aim for FY 1972 is to start the selection process of methods for making long-range projections. I must confess that current forecast models are not very good, yet so much depends upon the projections. Most econometric and statistical models need more theoretical refinements - let alone operational use.

The more common projections methods of ordinary least squares, instrumental variable estimation, indirect least squares, and two stage least squares don't fit most economic problems. While three stage least squares offers a full information system, it is highly abstract and seldom used expect in Monte Carlo sampling. Simultaneous equations systems are promising but few applications have been made. Input-output analysis is useful for sensitivity analysis but has major deficiencies when used as a projection technique because final demand and production coefficients are generated outside the system.

Given the deficiencies associated with each of the specified methods, the plan is to probably use more than one kind of model - a multi-model approach. Before any methodological decisions are made, however, several econometric experts of national stature will be consulted; additionally, more practical considerations will guide our selection processes which are:

a. The methods should be as scientific as possible and assumptions will be made explicit. Expensive models will be avoided where the technical gains over less expensive methods are not appreciable.

b. Models should have flexibility for reformulation of projections and assumptions as conditions warrant. The selected models should be available for continued use after the In-Depth study is completed.

c. Selected analytical methods should be free of excessive theoretical refinements and aligned with real world situations. In short, we want decision-makers to fully understand the analysis and not be overwhelmed by the technical mechanics of abstract models. Technical economics, like solid-state physics, is often incomprehensible to non-economists.

Projections and Conclusion

For the last part of my presentation, I would like to conclude with some personal observations on projections analysis - one of the principal outputs of our sub-study.

The recipients of projections usually have a great deal of skepticism about the numbers. This is quite understandable since projections are not precise and have increasing uncertainties as the time coordinate is extended. We should realize that projections are only estimates of future magnitudes and should be periodically revised as conditions change. I am trying to convince the users that one should not blindly follow a singular set of numbers for 20 - 30 years without integrating new events into them.

In our sub-study, we will try to bracket most of the possibilities with high and low estimates including identification of a most probable series. To allow for reasoned judgments and to provide latitude for accommodating changes, each projection series will have intervals such as near term, middle term and long term. Exhibit VII illustrates these intervals. The numbers are the mean of the interval values. The critical interval is the near term. Unfortunately, the large magnitudes in the nth year of a projection tend to overshadow the other figures.

FUTURE LEVELS OF WATERBORNE COMMERCE
SAN FRANCISCO BAY FACILITIES*
(MILLIONS OF TONS)

	1980-1985 (NEAR TERM)	1990-2000 (MIDDLE TERM)	2010-2030 (LONG TERM)
HIGH ESTIMATE			
LIQUID BULK	30.0	36.3	40.1
DRY BULK	13.6	25.4	31.7
SPECIAL HANDLING	2.3	5.6	8.5
GENERAL CARGO	3.5	4.8	6.4
TOTAL	49.4	72.1	86.7
MEDIUM ESTIMATE			
LIQUID BULK	26.1	31.6	34.9
DRY BULK	11.9	22.1	27.6
SPECIAL HANDLING	2.0	4.9	7.4
GENERAL CARGO	3.1	4.2	5.6
TOTAL	43.1	62.8	75.5
LOW ESTIMATE			
LIQUID BULK	23.4	28.4	31.4
DRY BULK	10.7	19.8	24.8
SPECIAL HANDLING	1.8	4.4	6.6
GENERAL CARGO	2.7	3.7	5.0
TOTAL	38.6	56.3	67.8

* This table is purely illustrative of final output.

EXHIBIT 7

Based on some valuable lessons learned in other interagency studies, I believe that the impact analyses associated with projection series is especially important. Impact analyses upon the regional economy will be performed for each particular set of projections. This will also include a detailed analysis of the competitive aspects among West Coast port systems.

In concluding, I hope you realize that our analysis will involve more than the development of numbers. This is the major point I wanted to get across here today. I have skimmed over many areas and if you have any questions I will try to answer them here or at a time more convenient to you.

THE PENN STATE WATERWAY SIMULATION MODEL

by

Joseph L. Carroll[1] and Michael S. Bronzini[2]

INTRODUCTION

Assessing the economic efficiency of improvements to the nation's waterway transportation system is a complex and difficult task. Furthermore, as demands upon the federal budget continue to escalate, it becomes increasingly important to carefully and thoroughly scrutinize all proposed investments in waterway transportation, both to avoid those projects with slim or illusory returns and to insure that truly efficacious projects are properly planned, designed, and operated.

In response to these needs, the Pennsylvania Transportation and Traffic Safety Center of The Pennsylvania State University, under contract to the U.S. Army Corps of Engineers (COE),[3] is engaged in a program of research with the objective of developing improved analytical tools for the planning and evaluation of waterway transport systems. The initial portion of this research was completed in July of 1971 and had as its immediate goal the development and application of computer simulation models suitable for exploring the operating characteristics of

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[1]Head, Transportation Systems Division, Pennsylvania Transportation and Traffic Safety Center, and Prof. of Business Administration, The Pennsylvania State University.

[2]Research Asst., Dept. of Civil Engineering and Pennsylvania Transportation and Traffic Safety Center, The Pennsylvania State University.

[3]Initial research was completed under contract with NCD & LMS with subsequent research efforts sponsored by OCE.

alternative inland navigation systems.

The results of this research are documented in a six-volume technical report, entitled "Waterway Systems Simulation" [1]. The intent of this paper is to provide a broad overview of the scope and accomplishments of the research completed to date.

A waterway is clearly a system of interdependent components. Although the traditional single-facility analysis is sufficient for non-congested systems in which the operation at one point has little effect on operations elsewhere, in congested systems, or in systems where facilities are closely adjacent, interdependence demands a systems analysis. In a capacity context, there should be a balance or an equalizing of the capacities of system components. Attempts to relieve congestion at one point in the system are likely to result in the transfer of congestion to other points. Local optimization may result in inefficient system operation.

INLAND WATERWAY SIMULATION MODEL

General Model Structure

Efforts prior to that described herein in the general area of waterway simulation have been exhaustively treated by the authors elsewhere [2]. The key step in passing from the previous simulation models to the present model was a fundamental shift in how the waterway is viewed. The emphasis in the earlier models was upon the movements of individual tows with unique identities, and the waterway itself was regarded as a sort of pipeline through which the tows were processed.

Commodity tonnages and origin-destination (O-D) patterns entered the model only through the tow itineraries and characteristics which were input to the model.

In the current model system the waterway is initially viewed as an interconnected network of ports, each of which originates and terminates waterborne freight. The movement of this freight is accomplished by allowing tows to originate and terminate at every port in the system, rather than at system end-points only. This, in turn, permits attention to be focused upon O-D tonnage movements and the balance of transport equipment throughput at each point in the system. The object of the simulation has thus become predicting the amount of equipment utilized and its pattern of movement through the system, together with associated service times and delays.

The simulation program itself still uses tow itineraries and characteristics as inputs. However, all itineraries now consist of O-D movements only, and tow characteristics are generated stochastically from empirically derived input distributions.

Operationally, the simulation model is divided into two parts. The first section is a tow generation program (TOWGEN), which produces a time-ordered list of tow arrivals into the system. This list is then processed by a waterway simulation program (WATSIM).

TOWGEN

The purpose of TOWGEN [1, Vol. III] is to convert commodity O-D tonnage matrices into a set of O-D movements of tows having known characteristics. The procedures followed insure a balance over time of equip-

ment types at all points in the system. Inputs consist of the following: (1) an O-D tonnage matrix for each of up to 10 commodities; (2) a table of barge data showing commodities carried, average loading, and commodities backhauled for each barge type; (3) a table showing mileages between all ports in the system; and (4) frequency distributions for the characteristics (flotilla size and towboat horsepower) of the tows expected to move the commodities. Output consists of a time-ordered list of tows of known characteristics as follows: (1) port origin and destination, (2) departure time of tow at origin port, (3) towboat horsepower, (4) number of loaded and empty barges, and (5) net tonnage.

TOWGEN itself is not a simulation model, but rather is one part of a simulation package. TOWGEN is, in a sense, a waterway traffic demand prediction model. Starting with the basic elements of (1) commodity transportation demand and (2) transport fleet supply, TOWGEN uses an array of analytical and Monte Carlo techniques to determine the waterway transport demand in terms of discrete traffic units (i.e., barge flotillas). The complex interactions between commodities, equipment, and the waterway system are modeled internally, thus freeing the analyst to concentrate his attention upon the underlying traffic demand factors. Not incidentally, these underlying factors (i.e., tonnage O-D and fleet characteristics) are much more amenable to observation and forecasting than the traffic demand is.

A unique feature of TOWGEN is the capability of controlling equipment utilization through specification of different levels of "empty backhaul." To the extent that empty backhauls can be avoided, equipment requirements are reduced as are traffic flows through the system. These

reduced flows are reflected in lower congestion levels output from WATSIM.

WATSIM

The actual simulator part of the model is WATSIM [1, Vol. II] which processes the tows output from TOWGEN. The present model will accommodate 30 ports, 20 delay points, and 75 chambers distributed among 30 different locks. Delay points may be channel restrictions or bridges, and the waterway may have up to five branches. Also, 10 each of barge types, towboat horsepowers, and flotilla sizes are permitted.

In addition to the input provided by TOWGEN are the following: (1) frequency distributions for locking time components, (2) parameters specifying the particular program options to be used, and (3) definition of the elements of the waterway system.

The structure of WATSIM is similar to that of most simulation models. Dynamic elements of the simulation are controlled by a scheduler routine, which moves tows through the system, selecting events for execution in proper sequence, and monitors overall program mechanics. Various system entity logic modules are invoked by the scheduler to perform actual event computations. Utility routines provide data checking, error processing, statistical computation, and report generation capabilities. Data storage and accessing are handled primarily by means of list structures.

WATSIM generates 12 tables of output information covering all aspects of system performance including tows processed, tonnage, delays, equipment inventories, etc. Selective output options may be exercised at the user's discretion.

MODEL APPLICATIONS

To date the TOWGEN-WATSIM simulation package has been used to study alternative designs for the following inland waterway systems:

(1) the Illinois-Mississippi 10-lock subsystem

(2) the Ohio River

(3) the Upper Mississippi River.

The first two of these applications were carried out at Penn State and are discussed below. The Upper Mississippi Study was conducted by North Central Division, COE. The successful completion of these studies has served to verify the versatility and usefulness of the model in analyzing waterways of varying complexity.

Ohio River Navigation Study

The purpose of this simulation study [1, Vol. VI] was to test the ability of alternative system designs for the Ohio River mainstem to handle projected traffic for the period between 1980 and 2030. Of particular interest were the operating characteristics of alternative facility improvements in the lower reach of the system. To accomplish these objectives, it was necessary to make 20 simulation runs. These were made with seven traffic forecasts and nine system variations.

The alternatives tested constituted a three-stage system evolution from its present configuration to that required to meet projected 2030 traffic demand. The first stage involves the completion of the COE's program to upgrade the Ohio River navigation system and to guarantee a 9-foot channel depth. This stage was expected to be completed some

time before 2010 with the construction of Mound City L&D and the elimination of L&D's 52 and 53. With the completion of the first stage of construction, the simulation study examined the improvement of the upper river reaches, by replacing small 360-by-110-foot and 360-by-56 foot chambers with 1200-by-110 foot locks at such sites at Emsworth, Dashields, and Montgomery. The final stage of the evolution involved the addition of 1200-by-110-foot chambers to the locks below Huntington, West Virginia. This improvement program was simulated in anticipation of increases in traffic flow in the river below Huntington. Part of these structures were programmed to be placed on-line by 2020 and the remainder by 2030.

Rather than follow a predetermined set of system designs, an analysis of each computer simulation was used to develop alternative designs for succeeding time periods. This allowed the introduction of improvements in the system when performance measures indicated unacceptable conditions at particular locations. As a result of this series of simulation runs, several system modifications which would accommodate the anticipated traffic demand with a reasonable amount of delay at lock facilities were identified. Further economic comparison of alternatives should indicate which construction alternative is most desirable.

Illinois-Mississippi Ten-Lock Subsystem

The purpose of this study [3] was to examine on a system basis alternative designs for the proposed duplicate locks on the Illinois Waterway and certain related improvements on the Upper Mississippi River. The focus of the study was upon the existing and potential delays to commercial traffic at the seven navigation locks on the Illinois River,

and at locks 25, 26, and 27 on the Upper Mississippi River, under various combinations of lock size and navigable channel depth. Tow delays, as predicted by the inland waterway simulation model, were used as the basis for assessing the system-wide impacts of several proposed design alternatives and construction sequences.

The design recommended by the Corps' Chicago District for the Illinois Waterway calls for new 1200-by-110-foot locks at each of the seven sites. The existing chambers would be retained as auxiliary chambers. The construction schedule proposed by the District calls for the new chambers to be put into service during the 15-year period from 1978 to 1993. St. Louis District has recommended that existing L&D 26 be replaced by twin 1200-by-110-foot structures. There are currently no official design recommendations for L&D 25 or L&D 27, but it is anticipated that the recommended size for new chambers at these sites will also be 1200 by 110 feet. Also under study by the Corps is provision of a minimum 12-foot channel depth on the Mississippi River and Illinois Waterway.

This study addressed all of the alternatives described above. In addition, provision of new 600-by-110-foot chambers, rather than 1200 by 110, was also considered.

Future Applications

As can be seen from the examples above, the TOWGEN-WATSIM simulation model is a useful tool for examining a number of inland waterway planning and design problems. Some of the particular questions which are susceptible to simulation analysis include: sizing of lock chambers;

number of chambers required; timing and sequencing of lock improvements; channel depth; location and number of navigation dams; and benefits of increased lock operating efficiency.

The model has been turned over to the Corps, and has been made operational on COE computing equipment by personnel at the Waterways Experiment Station. A research version of the model is also being used at Penn State for further studies of inland waterway operations.

CONCLUDING OBSERVATIONS

The ultimate goal of analyzing prospective waterway transportation projects in a systems context is to determine what improvements to a given waterway, if any, will result in the least cost to society of transporting goods in the market area served by the waterway. The simulation models developed in this research are useful tools for obtaining a partial answer to this question. It is important to realize, however, that answers derived from simulation are indeed only partial in nature. This is so primarily because simulation studies address only one half of the economic sphere of the waterway investment problem--that relating to transportation supply functions. The equally important topics of transport demand and the equilibrium of supply and demand can be treated within an exclusively simulation-oriented planning study only through parametric variation of the simulation inputs. Hence, a need exists to build around the simulation models a truly comprehensive systems analysis methodology which will be able to integrate diverse and complex waterway transport demand and supply phenomena. Work in this direction is currently underway at Penn State.

REFERENCES

1. Carroll, J. L., and Bronzini, M. S., eds., "Waterway Systems Simulation," 6 Vols., Reports TTSC 7108-TTSC 7113, Pennsylvania Transportation and Traffic Safety Center, The Pennsylvania State University, August 1971.

2. Carroll, J. L., and Bronzini, M. S., "Simulation of Waterway Transport Systems," Transportation Engineering Journal of ASCE, Vol. 97, No. TE3, Proc. Paper 8311, August 1971, pp. 527-539.

3. Carroll, J. L., and Bronzini, M. S., "Simulation Study of a Ten-Lock Subsystem for Illinois Waterway and Upper Mississippi River Navigation," Waterway Systems Simulation, Technical Memorandum No. 3, Pennsylvania Transportation and Traffic Safety Center, The Pennsylvania State University, September 1971.

ACKNOWLEDGEMENTS

This research was supported by the Army Corps of Engineers. Chief representative of the Corps throughout the study was Robert A. MacLauchlin, Economics Branch, North Central Division. Thanks are also due to the entire project team at Penn State: J. Rea, J. Herendeen, J. Hayward, J. Hummel, D. Nowading, K. Desai, J. Gimbel, G. McInnes, J. Guttin, P. Staadeker, and D. Weldon.

Memphis Harbor, Tennessee: An Ex Post Analysis

by Norman P. Swenson *+

Introduction

A Memphis District reviewer commenting on the "Proposed Principles and Standards for Planning Water and Related Land Resources" made the suggestion that in our comments to Division we should cite the highly successful Memphis Harbor project as an example of a project which would have proven unjustified if it had been evaluated at a 7 percent interest rate. His point being, of course, that high discount rates would screen potentially meritorious projects and therefore they are bad.

The position argued in this paper is quite the contrary, namely, that the Memphis Harbor Project could have been justified using high rates of discount and that the only reason for rejecting the project at a 7 percent rate would have been a failure to correctly estimate the commodity tonnages induced by the project. The villain in this scenario is not the use of high discount rates but is instead, the use of poor projection techniques and economic analysis on the part of the analyst.

History of the Project

The Memphis Harbor project was authorized on July 24, 1946 by amending the Act of May 15, 1928 which provides for improvements on the Lower Mississippi River. The plan provided for an off-river slack water harbor with provision for adequate terminal and industrial sites having both flood protection and direct access to water transportation.

* Chief, Economics Section, Planning and Reports Branch, Memphis District

+ Paper to be presented at the Workshop on Navigation and Port Studies Conference of Economics, Galveston, Texas, March 23, 1972

The project was phased in two parts. (Refer to attached project map.) Phase I was the development of industrial sites on President's Island. A closure dam was constructed across the Tennessee Chute of the Mississippi River providing access from the mainland to President's Island. Following the closure of the Tennessee Chute the channel was dredged and the spoil was strategically placed on the banks of President's Island to create about 960 acres of flood free industrial sites. Phase II consisted of the construction of a pumping station and eleven miles of levee on the mainland designed to protect 6,800 acres of land for the Frank C. Pidgeon Industrial Park. The first phase was completed in late 1951 and the second in 1967. We will be concerned only with Phase I in this paper.

Project Evaluation in Senate Document No. 51[1/]

Costs

The estimated Federal first cost shown in Senate Document 51 was $17,120,000 in 1946 dollars.[2/] The cost to the Federal Government on completion in 1967 is reported to be $18,737,000.[3/] This difference is only about 10 percent and since we are comparing constant dollars with the sum of current dollar figures, we cannot determine the true difference but we can infer that on the cost side the estimate was very good.

Benefits

Pre-project harbor capacity was estimated to be 3.7 million tons per year.[4/] No justification for this absolute capacity estimate is given. Project benefits were derived by applying a per unit transport cost saving to the aggregate projected commodity tonnage in excess of harbor capacity. Two

sets of projected tonnages were contained in the report. Local proponents of the project, the City of Memphis, the County of Shelby and the Memphis Harbor Commission, anticipated that the improvement would induce 1,900,000 additional tons per year ten years after completion of the industrial fill. They applied a transport saving of $1.60 per ton to this estimate for a total project benefit of $3.040 million.[5/] The Corps official tonnage projection was more conservatively estimated at 800,000 additional tons to be attained within a period of 10 years subsequent to project completion; however, the Corps applied a higher transport cost saving of $1.85 per ton. Total tangible monetary benefits were described as $1,480,000 annually with no discounting for development lag.[6/]

Benefit-cost ratios per se were not shown; however since project costs were annualized one could infer a benefit-cost ratio of 1.6.[7/]

Project Reevaluation Viewpoint 1952

For exposition we will annualize the costs and benefits shown in Senate Document 51 at interest rates of 2-1/2, 5-3/8, 7, and 10 percent over a project life of 50 years. Benefit evaluation is based on both the Corps and local proponents estimates of commodity tonnage. Later we will reevaluate using actual commodity tonnages experienced over the same period.

The period of analysis is defined to be the 50 year period subsequent to the completion of the harbor industrial fill on President's Island late in 1951.[8/] The relevant facts are shown to be:

Costs:

1.	Federal, First	$17,120,000
2.	Non Federal	410,000
3.	Maintenance, Annual	100,000

Benefits:

a. Corps estimates 800,000 tons at $1.85 saving per ton by year 1961.

b. Local proponents estimate 1,900,000 tons at $1.65 saving per ton by year 1961.

Period of analysis is 1952 through 2002.

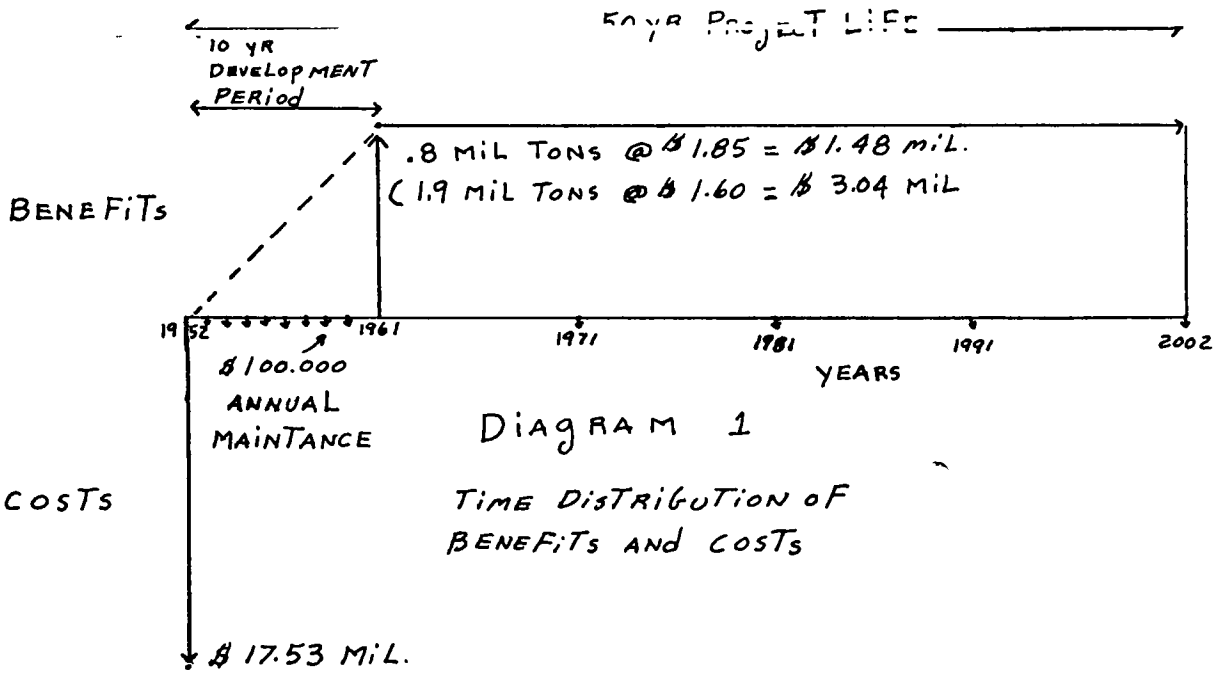


DIAGRAM 1

TIME DISTRIBUTION OF BENEFITS AND COSTS

The problem is shown schematically in diagram 1. We must convert the costs and benefits to annual equivalents for benefit-cost comparisons. These results are summarized below:

Interest Rate	Annual Costs	Annual Benefits		B/C Ratio	
		Corps	Local	Corps	Local
2-/2	$ 719,500	$1,265,200	$2,598,800	1.8	3.6
5-3/8	1,116,400	1,159,210	2,381,080	1.04	2.1
7	1,370,200	1,099,300	2,258,100	0.8	1.7
10	1,868,000	996,200	2,046,300	0.5	1.1

These data indicate that the project would not have been justified under the Corps benefit estimates at the higher discount rates but would have been justified if the local proponent's estimate had been accepted. Hence, even in the original study a high rate of discount would not have eliminated the project.

Reevaluation with Actual Tonnages

We now evaluate the project based upon the same ten year development period using actual tonnages instead of estimated tonnages. Table 1 (attached) shows the tonnages reported for the Port of Memphis for the years 1951 through 1961. The commodity movement induced by the new harbor is taken to be those tonnages in excess of the estimated harbor capacity before project, e. g., 3.7 million tons.

These "induced" tonnages have been converted to a comparable annual basis by summing the present values of the tonnages for each year in the development period plus the present value of the remaining 40 years and then taking this sum times an amortization factor.[9/]

The results of this computation using a transport saving of $1.85 per ton is shown below:

Interest Rate	Annual Costs	Annual Benefits	B/C Ratio
2-1/2	$ 719,500	$4,135,000	5.7
5-3/8	1,116,400	3,953,000	3.5
7	1,370,200	3,768,000	2.7
10	1,868,000	3,365,000	1.8

Under this set of calculations we see that the Memphis Harbor project is justified at each of the discount rates considered. The lesson taught here is simple; it is not high discount rates which make the project uneconomic but rather myopic commodity projections.

This exercise has been based on the restrictive assumptions and simple analysis, if the project were redone today the economic analysis would be more sophisticated. Commodity projection would be much more detailed, broken down into commodity classes by origin and designation, etc. Freight rate comparisons among alternative modes of transportation would be conducted in minute detail. However, the thorny problem of determining an absolute harbor capacity remains.

Today, local proponents claim that the harbor is again nearing capacity and they have requested the Corps to conduct studies to plan for expanded facilities. The Corps, in 1946, stated that harbor capacity under existing conditions was then 3.7 million tons, but no documentation was offered to support the assertion. In order to demonstrate need for harbor expansion it is necessary to define the "practical capacity" of the existing harbor

in an economic as well as physical sense. We would like to be able to relate harbor capacity to land and waterfront footage requirements. To this end the district is currently seeking a methodology to resolve this complex question. If we are successful the results of our study should be useful to other districts having responsibilities for development of inland harbors.

FOOTNOTES

1/ Most of the basic data for this paper is taken from "Improvement of the Mississippi River, Memphis, Tenn." Senate Document No. 51, 80th Congress, 1st Session.

2/ ibid. p. 9

3/ U. S. Army Corps of Engineers, Memphis District. Project Maps. 1970 revision p. 1-9.

4/ Senate Document No. 51, p. 6.

5/ ibid. p. 5, 9. The Memphis Freight Bureau arrived at this figure by comparing the difference between water and rail rates on all principal commodities shipped into or out of Memphis by water by origin and destination for the year 1944.

6/ ibid. p. 9. The Corps revised the freight saving figure upward to reflect 1946 conditions.

7/ Project costs were converted to annual charges at an unspecified interest rate over a period of 40 year useful life. These costs were $944,000. Subsequent updates of the project economic analysis for 1950, 1952 and 1960 through 1966 show various interest rates and project lives being carried. Federal funds were amortized at 2-1/2, 3, and 2.625 percent and non-Federal funds at 2-1/2, 3, 3-1/2, and 5 percent. Project lives were shown to be either 50 or 100 year.

8/ We are using total project costs which include phase II of the project and therefore overstate the true case, i.e., the transport savings benefit from the industrial fill components are made to carry the total project.

9/ Amortization is sinking fund plus interest (capital recovery).

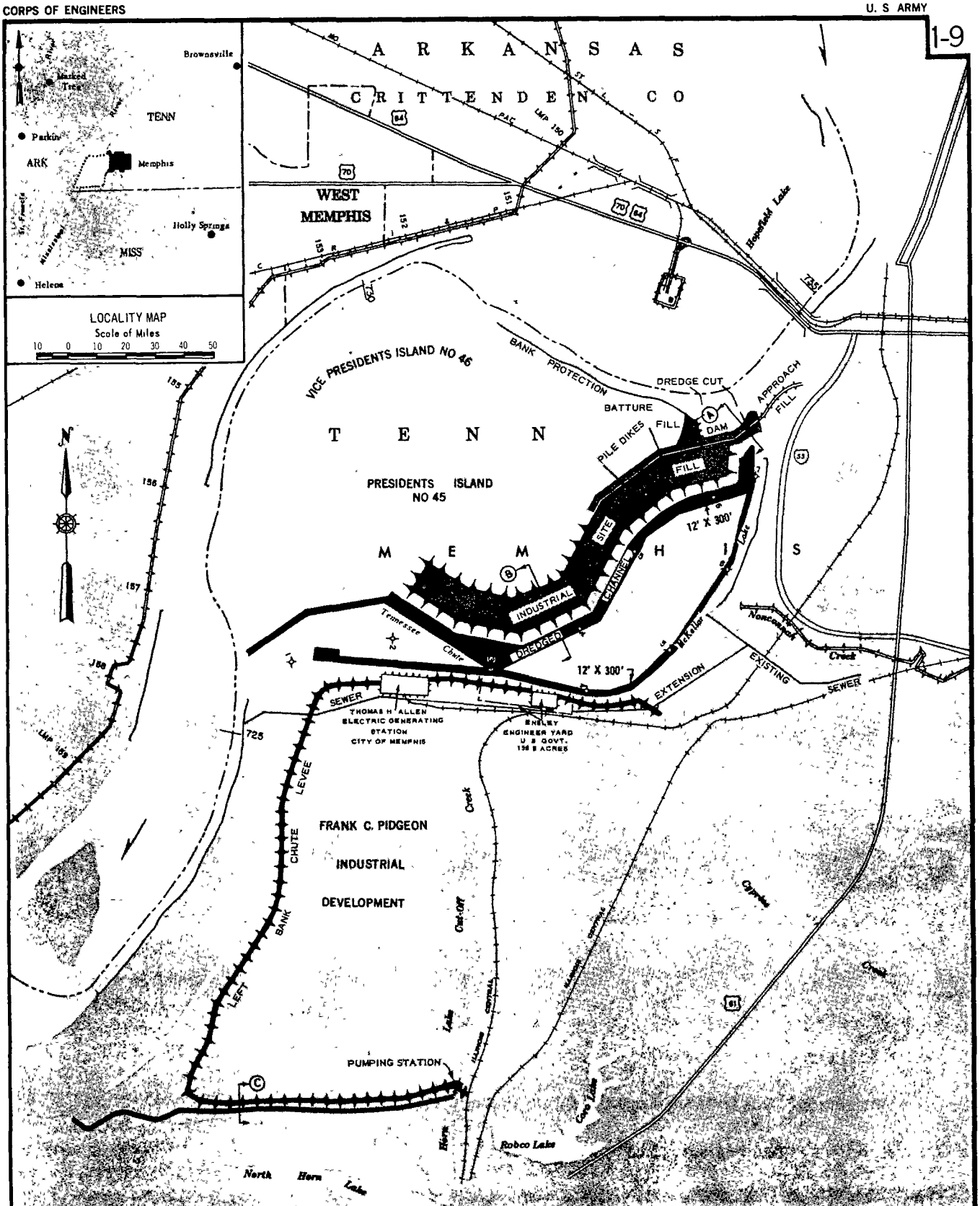
APPENDIX TABLE 1

Part of Memphis Tonnages, Actual and Induced

Year	Time Period	Thousands of Tons: Actual	Thousands of Tons: Induced[1/]
1951	0	3,113	0
1952	1	3,470	0
1953	2	3,491	0
1954	3	3,561	0
1955	4	3,970	270
1956	5	5,031	1,331
1957	6	5,439	1,739
1958	7	5,299	1,599
1959	8	6,319	2,629
1960	9	6,329	2,676
1961	10	6,876	3,199

1/ Based upon a pre-project harbor capacity of 3,700 thousand tons as designated in Senate Document 51, 80th Congress, 1st Session.

Source: Tonnages are from compilations in "An Analysis of Commodity Movements and Land Use Requirements on the Memphis Harbor, 1980-2030," Bureau of Business and Economic Research, Memphis State University, Memphis, Tennessee, May 1971.



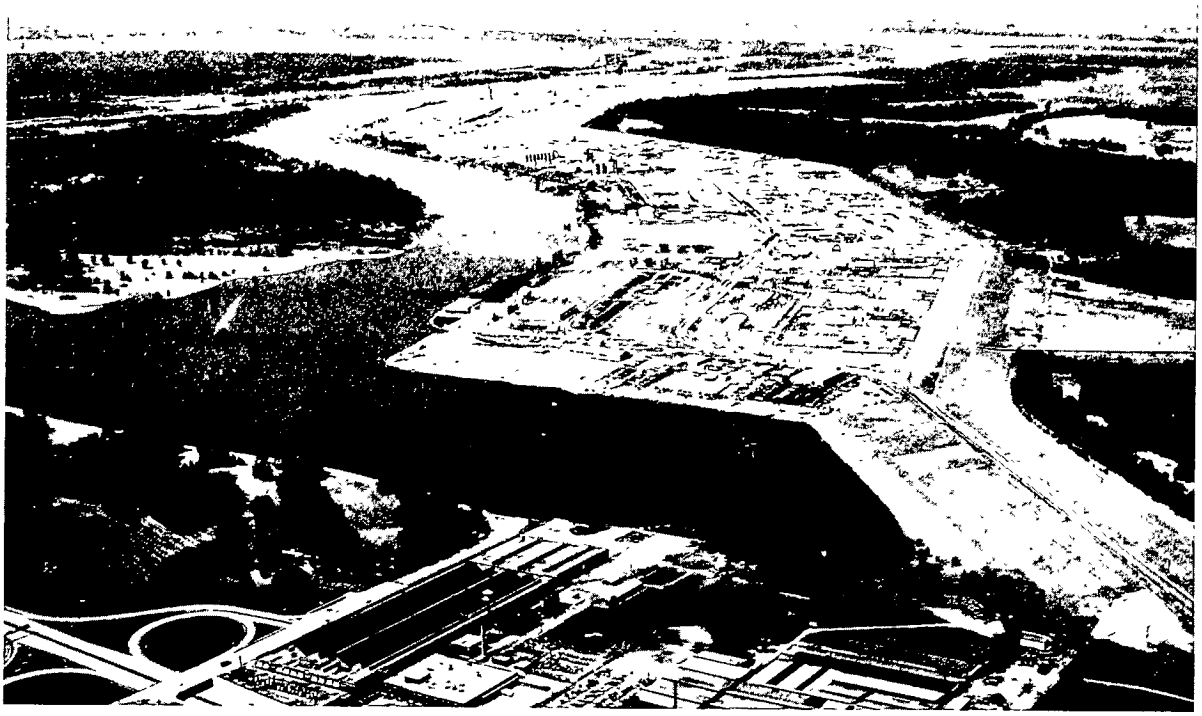
LEGEND

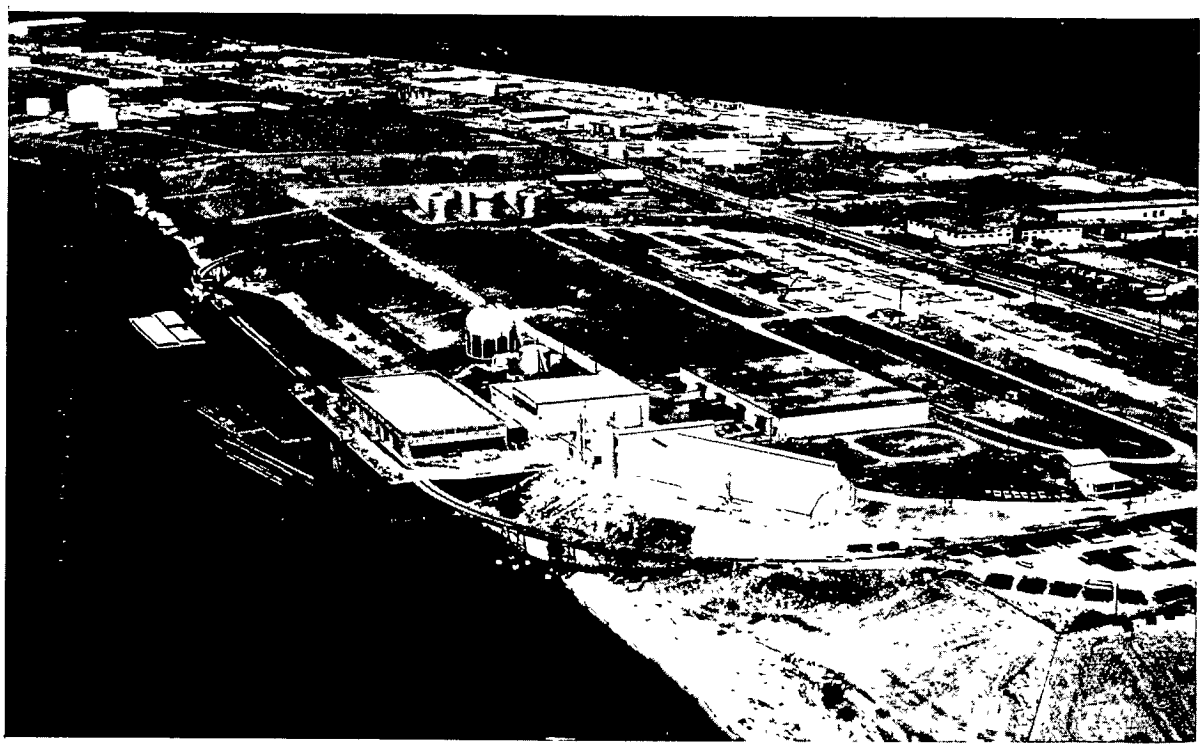
- CHANNEL ENLARGEMENT
- LEVEE
- REVETMENT
- FILL & CHANNEL

MISSISSIPPI RIVER COMMISSION

MISSISSIPPI RIVER
MEMPHIS HARBOR
OFFICE OF THE DISTRICT ENGINEER
MEMPHIS, TENNESSEE
30 JUNE 1968
Scale of Miles
½ 0 ½ 1 1 1/2

MEMPHIS HARBOR





AERIAL VIEW OF PRESIDENTS ISLAND INDUSTRIAL FILL,
SHOWING DEVELOPMENT OVER THE 960 ACRE AREA.

COMMENTS ON CONFERENCE OF ECONOMISTS AND DIRECTIONS FOR FUTURE RECREATION RESEARCH

Leonard Merewitz (Consultant)

The conference was particularly rewarding for me because I sensed the Corps' ability to change its activities and learn from its critics. I had tunnel vision previously and listening to Arlene Dietz of Chicago made me aware of the Corps' involvement in urban recreation, small craft harbors and harbors of refuge. I learned also of beach erosion control projects by the Corps. Perhaps the most encouraging aspect of the conference was Robert Harrison's mentioning "alienation." This signified to me a starting point for Corps' thinking which went to the most basic level of society's needs.

The major suggestions for future research which arose from Workshop No. 2 were (1) to investigate the supply of outdoor recreation and (2) to direct more attention toward urban recreation. One would want to study what recreation could be produced by combining natural resources with funds to buy labor and improvements. Attention could be paid to the possibility of using estuaries for water-based recreation that we formerly would have expected to serve at sites remote from cities.

It was acknowledged that the Hotelling-Clawson approach to demand analysis was inappropriate for analysis of urban recreation. Instead, a method which compares what cities actually "give up" or "spend" for urban recreation should be studied. These imputed "expenditures" take the form of foregone property and sales taxes. A cross-sectional comparison of

cities' willingness to pay for each visitor-day of recreation will be quite instructive.

The potential fruitfulness of the approach to measuring demand due to Kelvin Lancaster* was discussed. This approach is particularly useful for it is one of the few which allows us to predict the demand for a new goal or service.

Kalter and Merewitz discussed "regional estimators" produced by Sacramento District. I was not entirely clear on Kalter's statistical objection to those estimators. It seemed to me that the group of COE reservoirs in a District were sufficiently homogeneous to estimate a use prediction equation therefrom.

It has been customary to attribute the increased participation in outdoor recreation to:

(i) Increase in population

(ii) Greater amount of leisure time

(iii) More disposable or discretionary income

(iv) Better transportation.

The models proposed in the past have been based upon these hypotheses.

However, Hugh C. David ("Technological change and recreational planning" in "Elements of outdoor recreation planning," edited by B. L. Driver, University of Michigan. 1970) has suggested that there are more basic causes and that these more fundamental social and cultural changes should be analyzed by recreation planners. He discussed how the following changes will influence the future recreation market.

---

* "Change and Innovation in the Technology of Consumption," AER Supplement, May 1966, pp. 14-23.

(i) Shifting philosophy in our cultural viewpoint towards work.

(ii) Upward change in the man-hour production capacities in all major facets of the economy.

(iii) Major changes in the nature of the individual's work.

(iv) Urbanization.

Knowledge about these underlying social and cultural changes is of course of importance in projecting future needs and use.

I think that research on supply economics is very important. In the past, studies have concentrated on inventories of lands and waters available for recreational use. I don't imply that this is useless information. However, for economic analysis it is far from satisfactory. To be able to talk about supply we have to assess what costs will be incurred by making the resource available for recreational purposes.

The inventory statistics do not tell us anything about the development potential of the recreation resource. In view of the trends in recreation participation, greater pressures on our recreation resources seem inevitable. Therefore attention should be focused more and more on ways in which anticipated increase in demand can be matched by an equal expansion of supply.

One method of increasing supply is to enlarge total capacity. Since the enlargement can be done either by adding to existing facilities or by building new ones, two issues are of importance:

(i) Is there an optimum size for outdoor recreation facilities?

(ii) How large is the maximum potential gain from increased utilization?

The answers to these questions of course are to explore the relevant cost-curves.

Finally, at the workshop we mentioned that the same procedures used to measure benefits would be used to measure costs or recreational values foregone when wild rivers are spoiled by dams.

Systems Analysis of Recreational Boating Activities on Lake Michigan

Arlene L. Dietz
Chicago District, Corps of Engineers

STATEMENT OF PROBLEM

The problem to be solved by the Chicago District Office is where along the shore of Lake Michigan should improvements or developments of small boat harbor facilities be concentrated. In particular, where should developments be located in order to maximize the benefits to the boating public and at the same time minimize the adverse impacts and total expenditures. The question is really a complex one, asking specifically for the identification of the mix of facilities demanded (launching, transient, refuge, permanent berths and numerous service facilities) and where the different mixes should be sited along the shore to maximize the beneficial impacts. In addition, the time-phasing of site development to optimize limited study and construction funds as well as all beneficial impacts has to be considered. Therefore, the problem is three dimensional involving site location, facility mixes, and determination of a sequence of site developments.

PROBLEM ANALYSIS

The three dimensional problem outlined necessitated collective consideration for the eight separately authorized studies whose study areas together encompass the shoreline of southern, western, western and northern Lake Michigan. A comprehensive demand analysis and project evaluation was required. If each study were to be pursued independently, duplication of data collection and anlayses would result over time. Also, predicted

demands and related impacts would be of questionable validity since all projects interact to some degree, with each other. Also, the separate study approach would not optimize the limited available funds and manpower allocated for each study. The prime consideration became the development of an evaluation procedure to identify interaction of several alternative improvements stemming from the authorized studies. However, with either the separate study approach or any one systems approach used to date, an inherent difficulty in predicting demand for harbors providing transient and refuge facilities has been apparent. To overcome this deficiency, an analytical system approach is proposed designed to predict existing demand for refuge and transient facilities and at the same time capable of testing a variety of mixes of all alternative facilities at different sites and their impact in turn in the derived site demand for refuge and transient facilities. The analysis needs to be sensitive to a change in one or more of the system's component parts. This type of approach permits relative ease in revising the impacts of a proposed project under changing conditions. This flexibility is more critical over time when long lapses of time pass between project authorization and construction necessitating complete re-analysis of project impacts.

Small boat demand analysis to be discussed herein is designed to identify the area demand for permanently based and launch facilities and more importantly to identify the locales of the demand for transient and refuge facilities. Considering the possible approaches only a simulation adaptable to computer techniques appeared capable of identifying and measuring the refuge and transient demand which is derived primarily from the permanently based boats.

Turning to a model to tackle the analysis problem it was observed that recreational navigation had many attributes in common with commercial navigation's operational patterns. Each size of recreation craft has a predictable origin (function of population concentrations and vacation opportunities), a predictable destination (a function of distance from home port and recreational opportunities at each potential destination), and predictable intermediate stops (function of fuel, food and other utility consumption patterns, evening stop-over patterns, and storm occurrences). Granted the types of activities differ, but just as a commercial barge from one port can be predestined to another port in a simulation based upon a demand frequency distribution from port to port a recreational craft's movement from one given port or locale to another can be identified and frequency distributions established and applied. Also, tows carrying barges must occasionally be serviced at a lock or bridge and participate in fleeting activities. These activities, together with porting, may be impossible due to excessive demand at any point in time by other barges waiting to be serviced. The recreational craft with a predictable origin-destination pattern, having a defined pattern of intermediate stops for services and evening stops as well as refuge (function of predictable storm occurrences) may, as with the commercial craft, exceed the capacity of any one service area. The recreation craft simulation using the simulations developed for commercial traffic as a model, appears feasible considering the simularity of a recreational vessel's activity movements to the commercial vessels.

THE MODEL

The model will be composed of two parts; a traffic generation routine, and an activity simulation. The traffic generation routine will produce output which will serve as input into an activity simulation. The input into the traffic model includes the number of boats by size groupings for each major point of origin. This traffic generation model will use the daily sailing schedule distributions obtained from the 1971 experiences. Future projections for each point of origin will follow this schedule.

In order to simulate activities, on the traffic which has been generated, several additional system characteristics must be identified and input. For each stop one or more codes are assigned to identify the facilities it offers. The facilities identified will include food, fuel and all other utilities (treated collectively as utilities), transient berths, anchorage and on-shore storage facilities, launch facilities, refuge, recreational opportunities, and etc. Associated with the code will be a service capacity measured in number of boats according to size. Storm frequency distributions requiring boats to seek refuge will be input. For each boat size grouping the origin-destination distributions will be applied. Also, the frequency distributions for intermediate stops such as the utility stops, evening stops, recreation stops, etc., will be prepared and input. These distributions and those for storm frequencies will be used to predict a movement - activity schedule for each boat from each major point of origin.

The determinants of activity patterns (boat size, frequencies of utility, evening and final destinations), the storm frequency distributions, and the facility attributes (existing and proposed) will be used to predict the impact on existing and proposed facilities of future levels of boating

demand from the various points of origin. The resulting simulation will produce, by harbor, total and excess demand for the available facilities. Based upon the magnitude of the excess demand for each decade, the type, size and location of needed facilities will be determined.

DATA COLLECTION

The collection discussion considers that data required for the determination of the origin-destination patterns and the frequency distributions necessary to predict the activities while boats are in transient to the predicted destinations. These data will be collected from boaters by means of a mailer questionnaire. Several general questions are asked concerning the characteristics of the boat used, amount of use, and if it were not used on Lake Michigan, why not. The major portion of the questionnaire consists of origin-destination blocks for boaters to trace what are defined as "TYPICAL TRIPS". Associated with each trip block are questions relating to that trip. These include the number of people, the months, the number of trips for each indicated period, and the activities associated with each stop.

A pilot questionnaire (copy attached) was sent to a sample of registered boaters in each of three states, Wisconsin, Illinois, and Indiana. From the returns the final sample size will be established. The pilot questionnaire will be analyzed to establish the validity of each question and provide the basis for revision of the final questionnaire.

CONCLUSION

In conclusion it is hoped that this systems analysis of small boat activities along a contiguous shoreline will have general applicability

not only to Lake Michigan but also to the coasts and rivers facing similar problems. In addition, the data collection and analysis pursued for input likewise should serve as a useful format not only for input into this particular model but also into other related models.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

L. P. Voigt
Secretary

BOX 450
MADISON, WISCONSIN 53701

IN REPLY REFER TO: 1460-1

Dear Boater:

We need your help! Do you think there is a need for harbors or launching facilities on Lake Michigan? Here's your chance to let us know.

Wisconsin, in cooperation with other states, has asked the U.S. Army Corps of Engineers to study the need for new and improved small boat harbors along the western and southern shore of Lake Michigan. To help us determine these needs, please complete the attached questionnaire and return it in the enclosed prepaid envelope.

Your prompt response is vital. Please complete the form as soon as possible, preferably this week. Future facilities along Lake Michigan depend on your cooperation.

Very truly yours,

L. P. Voigt
Secretary

Enc.

LAKE MICHIGAN BOATING SURVEY

GENERAL INSTRUCTIONS

We would appreciate your taking a small amount of time to complete this questionnaire. Included are the following:

1. Thirteen general questions about your boat(s) and trip(s).

2. A question fourteen which asks you to trace several representative trips you made during the 1971 boating season. Detailed directions and an example of one such trip are provided to assist you. Also, the included map of Lake Michigan, its harbors and environs will be helpful in locating stops.

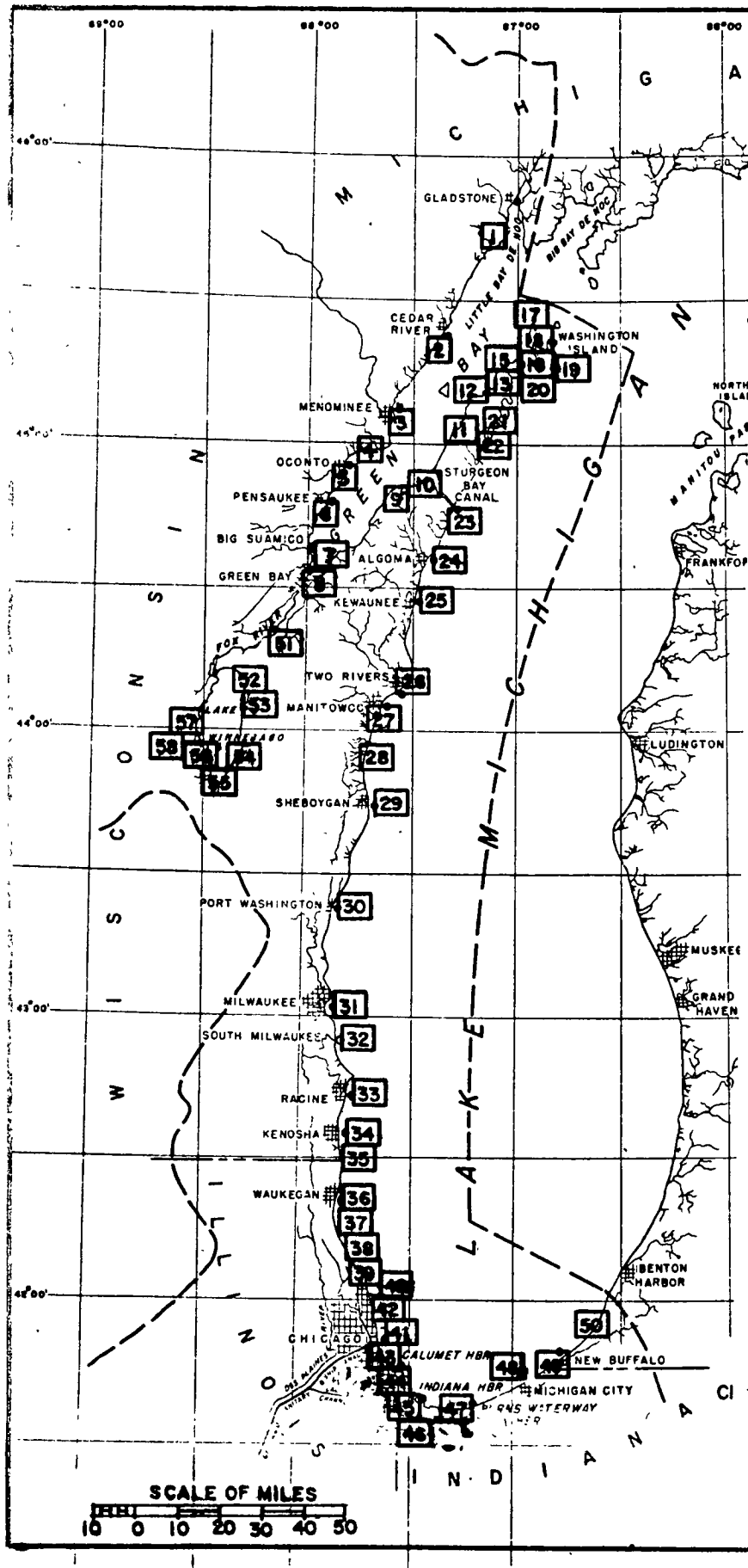
3. An addressed, stamped envelope for return of the questionnaire to our office.

Should you misplace the envelope, please send this questionnaire to:

Chicago District
U.S. Army Corps of Engineers
219 South Dearborn Street
Chicago, Illinois 60604
Attn: NCCPD-ERE - Boat Survey

Thank you.

Lake Michigan Boating Survey



1. All stops north of Cedar R.
2. Cedar R.
3. Menominee R.
4. Peshtigo R.
5. Oconto R.
6. Pensaukee R.
7. Big Suamico R.
8. Green Bay
9. Little Sturgeon Bay
10. High Cliff
11. Egg Harbor
12. Fish Creek
13. Ephraim
14. Sister Bay
15. Ellison Bay
16. Gills Rock
17. Washington Hbr.
18. Jackson Hbr.
19. Detroit Hbr.
20. Rowley Bay
21. Baileys Harbor
22. Jacksonport
23. Sturgeon Bay
24. Algoma Hbr.
25. Kewaunee Hbr.
26. Two Rivers
27. Manitowoc
28. Cleveland
29. Sheboygan
30. Port Washington
31. Milwaukee
32. South Milwaukee
33. Racine
34. Kenosha
35. Pompeii on the Lake
36. Waukegan
37. Gr. Lks. Tr. Ctr.
38. Highland Park
39. Wilmette
40. Belmont Hbr.
41. Chicago Hbr.
42. Jackson Park
43. Calumet Harbor
44. Indiana Harbor
45. Gary
46. Burns Waterway
47. Burns Harbor
48. Michigan City
49. New Buffalo
50. All stops north of New Buffalo
51. Lower Fox from De Pere to Neenah
52. High Cliff
53. Calumet Co. Park
54. Calumet Harbor
55. Fond du Lac
56. Pioneer Inn Hbr.
57. Millers Bay
58. Upper Fox and Wolf Rvs.

LAKE MICHIGAN BOATING SURVEY

for office use only
1000

1-5

6

1. How many boats did you own during the 1971 boating season that you used for your own (or family's) personal recreation?_____boats. — 7

CONTINUE ONLY IF YOU OWNED AT LEAST ONE BOAT AND OPERATED IT FOR YOUR OWN OR FAMILY'S PERSONAL RECREATION. OTHERWISE STOP AND RETURN THE QUESTIONNAIRE IN THE ENCLOSED STAMPED ENVELOPE.

2. Please indicate the county and state you live in:_____county. _____state. — 8-10

OWNERS HAVING ONLY ONE BOAT: CONTINUE ONTO QUESTION 3. OWNERS HAVING MORE THAN ONE BOAT: ANSWER ALL REMAINING QUESTIONS WITH REGARD TO THE BOAT YOU USED MOST OR WOULD HAVE USED MOST ON LAKE MICHIGAN. — 11

3. Please circle the general category of your boat: — 12
   a. Inboard
   b. Inboard-outdrive
   c. Outboard
   d. Sailboat without auxiliary motor
   e. Sailboat with auxiliary motor
   f. Other_____

4. Please circle the description which most nearly fits your boat: — 13
   a. Cabin (sleeping facilities)
   b. Cabin (no sleeping facilities)
   c. Runabout
   d. Other_____

5. What is your boat's maximum draft?_____feet. — 14-15

6. To the nearest foot, what is the length of your boat?_____feet. — 16-17

7. What is the horsepower of the main motor or motors of your boat? _____horsepower. — 18-20

8. How old is your boat?_____years. — 21-22

9. Did you operate your boat on Lake Michigan in 1971? This includes Green Bay and Lake Winnebago. (Circle one) a. Yes b. No — 23

IF YOU ANSWERED NO TO #9 ABOVE, COMPLETE THE NEXT QUESTION AND STOP; RETURN QUESTIONNAIRE IN ENVELOPE. IF YOU ANSWERED YES, SKIP NEXT QUESTION (#10) AND COMPLETE FORM.

10. The reason for not operating on Lake Michigan was because: (Circle one) — 24
   a. Lake Michigan is too far from residence
   b. Boat size considered unsafe for navigation on Lake Michigan
   c. No permanent berth, anchorage, or storage facilities available on Lake Michigan
   d. No convenient launching facilities available
   e. Other_____

11. What is your average cruising speed on Lake Michigan?_____knots/hour. — 25-26

12. Home port (Harbor at which your boat had a berth, anchorage or storage privileges for the season.) Indicate NONE if you launched your boat. _____home port. — 27-30

LAKE MICHIGAN BOATING SURVEY

SPECIFIC INSTRUCTIONS FOR QUESTION 14

The next portion of the questionnaire asks you to trace one or more representative trips you made during the 1971 boating season. Included are jaunts of less than a day's duration from home harbor.

Your cooperation by completing this last part of the questionnaire is desired to help us identify and plan for your boating needs. For example, the itineraries traced out by you and other boaters will provide the base data required by state recreation planners to identify as well as justify improvements to existing facilities and establishment of new ones.

14. Please fill out an attached origin-destination (O-D) form for each "typical trip" in 1971. A "typical trip" is defined as follows: One trip which is similar in port of origin, intermediate stops, and final destination to one or more trips. For example, suppose you took twelve trips on Lake Michigan during 1971, and let's further assume that five had common origin-destinations with similar (but not necessarily the same) stops (e.g. Chicago, Racine, Milwaukee, Racine, and Chicago.) The remaining seven trips might be represented by one or more typical trips.

a. Fill out the O-D block as shown in the example on the following page. Using the map, locate the origin, intermediate stops, and final destination (the numbers are for your benefit) for each typical trip. If your stops do not correspond to any map number, use the next closest and explain in the space set aside for comment at the end of the questionnaire. Include, in addition, arrival and departure times, and the days of the week. Also, the reason for each stop should be identified according to the "legend" which is located to the right of each O-D block.

b. Indicate the average number of persons aboard and the actual trips and their dates as represented by the associated typical trip. Spaces for this will be found on the O-D blocks.

c. Restating, one O-D block should be completed for each "typical trip" as defined above. Any substantially different trips (see 14b.) must be entered on another O-D block.

d. Should the number of stops exceed eight, continue that trip onto the next O-D block and indicate this by writing "continued" at the top of that block.

e. An example of the typical trip discussed on the last page is shown below:

ORIGIN-DESTINATION FORM

TYPICAL TRIP

(8-11) location	(12-14) arrival time*	(15-16) departure time*	(18-19) day of week	(20-24) reason for stop°	
Chicago	—	8a	Sat.	f	(01)
Racine	12 noon	1p	"	b, g (see friend)	(02)
Milwaukee	3p	4p	"	e	(03)
Racine	6p	7p	"	b	(04)
Chicago	11p	—	"	f	(05)
					(06)
					(07)
					(08)
(8-11)	(12-14)	(15-16)	(18-19)	(20-24)	

*round off to nearest hour-- e.g. 3:35 p.m. = 4p, 7:20 a.m. = 7a.

_____ - _____
(1-5) (6-7)

°legend

a. refuge from storm
b. food, fuel, and sanitary
c. evening stop-over
d. recreation, water-related
e. recreation, land-related
f. home port (origin)
g. other (comment in space to left)

Average number of persons aboard: 3 persons. (8-9)
Please indicate in the boxes below, the number of actual trips, represented by the above typical trip, undertaken in the stated time periods.

before 5/1 [ ] (01)	5/1-5/14 [ ] (02)	5/15-5/31 [ ] (03)	6/1-6/14 [1] (04)	6/15-6/30 [ ] (05)	7/1-7/14 [2] (06)
7/15-7/31 [ ] (07)	8/1-8/14 [1] (08)	8/15-8/31 [ ] (09)	9/1-9/14 [1] (10)	9/15-9/30 [ ] (11)	after 9/30 [ ] (12)

A PILOT STUDY IN FLOOD PLAIN MANAGEMENT AT PULLMAN, WASHINGTON

By

Paul C. Fredericks

IWR has had two research studies done in flood plain management; one by TRW Systems Group of California, and the other by the University of Chicago. The purpose of this pilot study is to test the practical application of the methodology suggested in the research.

The TRW and University of Chicago studies have two common themes: first, that flood plain planning should incorporate other goals in addition to flood damage reduction; second, that a variety of measures should be considered to achieve the goals.

Pullman is a small city of about 20,000 in rural eastern Washington. In contrast to other communities in the area, its population nearly doubled from 1960 to 1970. It is the home of Washington State University and the commercial center for a large surrounding area. Pullman was chosen as the study area to test the methodology suggested in the research for several reasons:

1. A flood hazard exists in Pullman and at the same time there are demands on the flood plain for recreation and commercial uses.

2. A flood control project was studied and authorized here in 1963 but deferred at the request of local government and a flood plain information study was done in 1969 so data is available.

3. City officials and citizens would like to achieve several objectives in the use of the flood plain and are actively involved in seeking solutions.

4. The hydraulics lab at Washington State University is doing a study in flood plain management for the State of Washington using Pullman as the study area.

The first phase of the pilot study was to test the methods suggested by the University of Chicago for determining community objectives for the flood plain. The methods suggested were:

1. A questionnaire given to community "influentials"; those whose support is crucial to the success of a program.

2. Analysis of planning documents related to the community.

3. Review of past development decisions.

Of these, I found the questionnaire to influentials most productive. In the analysis of planning documents there seemed to be a considerable lag in time between changes in community goals and their appearance in planning documents. This also seemed true of analysis of past development decisions. However, these approaches did yield much useful information.

The first step in the "influentials" approach was to determine who the influentials are. This was done by interviewing the editor of the city newspaper, manager of a local bank, and others in similar capacities. The influentials identified by these interviews included city officials, leaders of groups like the Chamber of Commerce, League of Women Voters, and others. I then gave the influentials a questionnaire to determine what objectives they felt the community would like to achieve by a program for the flood plain. The objectives indicated were:

1. To reduce flood damages.

2. To provide space for recreation purposes.

3. To provide space for parking and for commercial development.

4. To enhance the appearance of the stream flowing through town.

The questionnaire was administered primarily in person. Some were completed by mail. I found the questionnaire an effective means of determining community goals. It also has the side benefits of helping to establish rapport with community leaders. However, it is time-consuming to identify influentials and administer the questionnaire to them.

To the community objectives were added the traditional Corps objectives of maximizing net benefits and reducing the risk of catastrophic loss.

The next phase of the study was to take the objectives and apply the procedure suggested by TRW for developing plans. The procedure is to consider: (1) structural measures, (2) non-structural measures, (3) alternatives outside the flood plain, and, finally, combinations of the three.

Since the final decision on a course of action is completely circumscribed by the alternatives which are presented for consideration,

it is critical that a range of plans be considered. On the other hand, a very real problem from an operational standpoint is the number of possible plans that can be developed and analyzed and still keep study time and costs reasonable.

The structural measures being studied are large, medium and small channel enlargements, detention dams, and modifications of the railroads dissecting the flood plain. The nonstructural measures to be looked at are land-use regulations, floodproofing, early warning and evacuation, purchase of flood plain lands, and flood insurance. Alternatives outside the flood plain are: other locations for commercial development and relocation of damageable property like house trailers. An example of a combination of the three types of solutions would be channel enlargement in selected reaches, with land-use regulations, flood insurance and relocation of damageable property.

Each of the plans must be evaluated to measure its performance with regard to the various objectives. This has been done for structural plans and is proceeding for nonstructural plans. One of the problems is finding suitable units of measure for the achievement of non-dollar objectives.

The final stage of the pilot study will be a test of the methods suggested in the TRW report for comparing and evaluating plans. These are:

1. Trade-off analysis

2. The critical value method

3. Decision analysis

The most promising of these at first glance appears to be the critical value approach, although all will be tested.

The critical value approach begins with a comparison matrix of plans and objectives. Ranges of willingness-to-pay values for the non-dollar objectives are established. Then a pairwise comparison will be made between plans with respect to total willingness-to-pay, using values most favorable to one plan and least favorable to the other, and vice versa. This process will identify inferior plans, which are then eliminated. The ranges of willingness-to-pay values can be narrowed until one, or a couple of plans are left.

Hopefully, this pilot study will identify those elements of the tested methodology which are suitable for incorporation in Corps-wide guidelines for multiple-objective, multiple-means flood plain studies.

Also, it is hoped this pilot study will contribute to an actual plan of improvement to be implemented in Pullman. The authorized, but deferred, channel project is now being restudied by the Walla Walla District in close cooperation with the City of Pullman.

St. Louis SMSA Land Use Model for Regional Economic Analysis of Multiple Projects

Andre B. Corbeau and Carl F. Meyer
University of Missouri-St. Louis

Ronald Roberts
St. Louis District, Corps of Engineers

Introduction. There are two specific categories of tangible benefits accruing from urban flood control, one being a reduction of damage to property, and the second being a benefit attributable to changed land use. The latter category generally refers to a higher type of land use; for example, from agricultural use to industrial or recreational use. This article describes a land use forecasting model developed to aid the preparation of economic analyses for a number of projects under study in the St. Louis Metropolitan Area.* Some of these projects include Columbia Bottoms, St. Louis County (22 major tributary streams), East St. Louis and Vicinity (East Side Levee and Sanitary District), St. Louis Harbor, and Silver Creek Basin. Most of these project areas are not fully developed, thus exhibiting open space or land which could be developed if certain undesirable attributes were remedied. These projects, if constructed, would ultimately provide additional land resources for higher uses within the St. Louis Region. In order to view this potential of a higher order land resource use as a benefit in a specific planning study, it must be shown that there is a real need for additional land or that land deficits exist in these specific demand areas in the St. Louis Region, or in fact, that the future land demand can be met more efficiently through the partial utilization of protected floodplain lands. It is clear that a comprehensive study is essential in an attempt to precisely answer the following questions:

a. What proportion of the existing land base in the region is developed?

b. What is the future demand for land; i.e., 1980, 2000, 2030?

c. What land is currently available for development?

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*The St. Louis Metropolitan Statistical Area encompasses the Missouri counties of St. Charles, Franklin, Jefferson, St. Louis, and the City of St. Louis, and the Illinois counties of St. Clair, Madison, and Monroe.

d. What are the critical variables that will influence developmental patterns?

e. What type of development is likely to occur on currently protected land on which improved interior drainage is provided, or on unprotected land on which flood control is provided?

In summary, the quantification of benefits applicable to changed land use as the result of a specific project effort requires (1) defining future land needs in the appropriate impact area, (2) establishing the fact that these land needs can be provided more efficiently (the net return from the development in the project area is greater than that in an adjacent similar area). Due to the complexity of the St. Louis Metropolitan area and the existing synergistic traits, it was concluded that the system of regional development must be defined and analyzed.

Land Use Model. The St. Louis SMSA model is a computer oriented model designed to forecast land-use in ten year increments to the year 2030. The components of the model include a set of dependent variables, a set of independent variables, a set of initial data, a set of parameters and a set of exogenously determined macro-forecasts. These elements are combined within the model to provide areal forecasts for each land-use classification. See Figure 1.

The set of dependent variables consists of the various land-use categories, industrial, residential, commercial, public, recreational, agricultural, and vacant. Each of these categories is measured in land units, and the forecasts are made on ordered basis. In other words, these land-uses are ranked in order of importance so that two or more uses cannot compete for the same unit of land. Thus, the model forecasts industrial land use initially, then on the basis of this forecast, residential land use is then allocated. Given the forecasts for industrial and residential utilization, the next

category to be forecast is commerical utilization. Public and recreational uses are then forecast. Agricultural and vacant land are residual uses, and it is from these categories that land for the other uses is obtained; consequently, as time progresses their size is diminished.

The independent variables consist of a set of factors which influence land developments. Some of these variables represent characteristics of the land itself while others represent degrees of development that may render individual units more attractive for some uses. There are seven independent variables. The soil and topographical aspects of a land unit represent the first variable and are measured by a ranking, excellent, average and poor. A land unit whose soil, slope, drainage etc. are superior for urban development would receive an excellent rating. All land units receive a ranking for soil and topographical characteristics and it is assumed that the rating applies to any land use. The second independent variable consists of zoning and other local restrictions. For each land unit, the percentage of land zoned for each land use is compiled. The third and fourth variables indicate within each land unit the existence areas of unusual or historical value and the existence of water or sewage facilities. The final two variables are clusters of development and access to transportation. Although classified as independent variables, these categories are quasi-dependent in that forecasts are made for them. A cluster of development is broadly defined as a concentration of economic activity. Included in this category are such items as the central business district, major commerical centers, industrial parks or districts, major office centers, and county seats. The various clusters of development are identified with respect to type and provision is made for those clusters that encompass more than one land unit. Access to transportation is a variable which attempts to grade the various land units by their

proximity to various types of transportation systems. The transportation systems identified for this category are two-lane highways, four-lane or greater lane highways, intersections to limited access freeways, direct of indirect rapid transit systems, railroads and navigable waterways. Access is measured in terms of miles from the centroid of the land unit to the specific transportation system.

The set of initial data consists of the identification of land units, number of people engaged in a particular land use, the number of acres in a land unit and the percentage of land devoted to each land use. The unit of land used in the model was chosen on the basis of homogeneity and suitability for data collection. These criteria led to the adoption of census tracts as the unit of land. In those cases where a census tract was considered too heterogenous with respect to topography or some other independent variable, the tract was divided into enumeration districts. Thus, the majority of land units consist of census tracts. For each land use, the number of people devoted to the use and the percentage of the land being utilized for that use were tabulated on the basis of 1970 information. Also, each land unit included identification and measures for the various independent variables. In addition to the 1970 data compiled for each land unit, future information was identified where practical. For example, the changes in land use effected by major redevelopment plans or changes in access to transportation effected by proposed new highway construction were incorporated in the basic data to take effect at the approximate date.

The set of parameters incorporated in the model is inserted for two purposes, to allow greater flexibility to incorporate the effects of major governmental decision making changes and to prevent the over utilization of individual land units in particular land uses. One subset of the parameters

consists of a set of values that reflect the effects upon future urban development of governmental decision making. For example, the location of a major new airport or the construction of a rapid transit system has profound effects upon the urban development of a region. The parameters allow a system override to take place during the iterative operation of the model at some future time period. Essentially, this override changes the land use configuration as forecast to a new configuration dependent upon the values of the parameters. The inclusion of the parameters in the model yields a simulation capability for both macro and micro alterations dictated by governmental decision making changes. The other subset of parameters is a set of densities of land utilization. The inclusion of these densities into the model is based upon the assumption that a unit of land may pass through several stages of density with respect to a particular land use. For the various land uses a set of density parameters is included, which limit the degree of land utilization at each time period. Also included is a maximum density which precludes the consideration of the land unit for further utilization in a specific use. The densities for each land use were determined by a combination of heuristic and empirical observation. The historical development of the St. Louis SMSA, the characteristics of specific areas within the SMSA, and observation of other areas with similar attributes in the country were all combined to evaluate these densities.

The final input to the model is a set of exogenously determined macro-forecasts for the metropolitan area. The St. Louis SMSA is composed of 6 counties in Missouri and Illinois and the City of St. Louis. The macro-forecasts which serve as model input are county and region predictions at ten year intervals to the year 2030. The predictions are made for population and employment. These values serve as a base or datum for the model. The

function of the model is to allocate these forecasts to the various land units within the region. The allocation procedure decomposes these forecasts into the various land uses and translates the values into area of land used for each category.

The various input classifications are combined by the model to obtain ten year forecasts of land use. The process by which these forecasts are obtained can now be described. See Figure 2. Since the model allocates by an iterative procedure and time limitations preclude a complete discussion, the description will be limited to the allocation of industrial land. As mentioned previously, the various land uses are ordered with respect to priority. This priority results in a forecast for industrial use first; then given the industrial forecast, residential use is forecast and so forth.

The initial step in the formulation of the forecast for industrial land is to translate the macro-forecast for employment by industry into acreage requirements per county. These requirements are based upon a heuristically developed set of constants. The acreage requirements and number employed are retained to be allocated within the individual land units. Next, an inventory of available land is compiled from within the area encompassed by the county. This inventory is compiled by identifying the area available from agricultural and vacant land. Included in the inventory is all land currently used for industrial purposes. At this point, an initial check is made with respect to the set of independent variables to eliminate all land that is unsuitable for industrial development. The land may be unsuitable for a variety of reasons. For example, the soil or topography may be such as to preclude the land for development. The residual land represents the total amount potentially available for industrial use. The identification of the land with respect to the land

unit is retained throughout this procedure.

The next step in the process is to obtain a ranking of the units that include eligible industrial land. This ranking is obtained by a matrix of measures obtained from the set of independent variables. For each individual independent variable a rating for suitability is extracted. For example, the soil and topographical characteristics may be average for a specific land unit. The access to transportation may be excellent, e.g., the land may be located on a railroad spur. Each individual variable yields a rating of this nature. The matrix of measures combines the ratings from the variables to provide a ranking for the land units is the most important facet of the model. This combination is achieved primarily through empirical observation of development in other areas, tempered with judgment and experience. Since no universally applicable quantitative measure is available to apply in ranking suitability of land for various uses, judgment and empiricism seem to offer the best approximation to an optimal measure.

When the units of land are finally ranked for suitability, the densities of existing industrially used land are checked against the exogenous parameters mentioned previously. If the present density is less than the exogenous density the model allocates industrial use to reach the exogenous density. If excess land is available for industrial use and the presently used is less than the exogenous density, part of the industrial demand is allocated to new land and part is allocated to already utilized industrial land. This process of allocation is continued until the demand for land is satisfied. Upon the completion of the industrial allocation, the next land use category is considered in the same fashion,

FIGURE 1

ST. LOUIS SMSA LAND-USE FORECASTING MODEL

INPUT

1. 1970 LAND-USES BY LAND UNIT
2. 1970 FACTORS AFFECTING LAND-USE DEVELOPMENT
3. TEN-YEAR REGIONAL FORECASTS OF POPULATION AND EMPLOYMENT

MODEL

1. ESTABLISHES RANKING OF LAND UNITS IN ORDER OF SUITABILITY FOR INDIVIDUAL LAND-USES
2. ALLOCATES REGIONAL FORECASTS TO INDIVIDUAL LAND UNITS
3. ALLOWS FOR INSERTION OF EXOGENOUS FACTORS TO OVERRIDE PREFERENCE RANKING

OUTPUT

TEN-YEAR LAND-USE FORECASTS BY LAND UNIT

MODEL LOGIC (INDUSTRIAL LAND-USE FORECAST)

A. VARIABLES

n : Number of land units.

$R_{1,t+1}$: Regional industrial employment forecast for the $t+1^{th}$ time period.

A_{jt} : Number of acres used industrially in the j^{th} land unit for the t^{th} time period.

$A_{j,t+1}$: Forecast of the number of acres to be used industrially in the j^{th} land unit for the $t+1^{th}$ time period.

P_{jt} : Number of people employed industrially in the j^{th} land unit for the t^{th} time period.

I_{mj} : Measure indicating the potential influence of the m^{th} factor on industrial land use in the j^{th} land unit.

ED_k : Exogenously determined industrial land use densities, $k=1,\ldots,v$

D_{jt} : Density in the j^{th} land unit for the t^{th} time period.

AA_{jt} : Number of new acres available in the j^{th} land unit for the t^{th} time period.

B. ALLOCATION PROCEDURE

1. Compute AA_{jt} = (Vacant + Agriculture) for $j=1,n$
2. Compare D_{jt} to ED_k for $j=1,n$
3. Rank industrial land for suitability:

$$\text{RANK}\ (A_{jt}, AA_{jt})_k = f_m\left(\sum_{m=1}^{7} I_{mj}\right) \quad k=r,\ldots,n,\ldots s$$

($r,\ldots,n,\ldots s$ is a permutation of the n land units)

4. Allocate $R_{1,t+1}$ to ranking on basis of a minimum density to newly available industrial land and on exogenous densities to existing industrial land.

SECTION IV

APPENDIX

DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
Washington, D.C. 20314

DAEN-CW/IWRES

EC 1165-2-111

Circular
No. 1165-2-111

15 February 1972

EXPIRES 31 MARCH 1972

WATER RESOURCES POLICIES AND AUTHORITIES
Conference of Economists

1. Purpose. To announce a conference for Corps economists, and to solicit nominations and other relevant information.

2. Applicability. This circular applies to all Corps of Engineers installations with civil works planning responsibilities.

3. Discussion.

a. Objective.

(1) The number of economists in the Corps of Engineers is growing. Their task is steadily becoming more complex. It is vital to the success of the Corps program that the economic staff have high competence, a keen awareness of the immediate and prospective resource needs of the nation and an understanding of how the Corps can effectively help to meet these needs.

(2) Responsive to these aims, staff of the Office of the Chief of Engineers and the Board of Engineers for Rivers and Harbors will lead and moderate a discussion on current questions of special concern to economists. These include status of the proposed Principles and Standards recommended by the Water Resources Council, progress on the preparation of guidelines required under Section 122 of the Rivers and Harbors Act of 1970, and new procedures being tested for evaluation of economic benefits for flood control and related programs.

(3) The Institute for Water Resources will present its economic research program with emphasis on the ways in which economic research results can be applied to Corps of Engineers water resource planning. One of the major objectives of the conference is to exchange ideas on how the economic research of the Corps can be made more effective through (a) the selection of and priority given to research topics; (b) arrangements for cooperative research efforts with Division and District offices; and (c) more effective interpretation of research results.

b. Responsibility. The conference will be jointly sponsored by the Board of Engineers for Rivers and Harbors, the Directorate of Civil Works and the Institute for Water Resources.

c. Attendance.

(1) Selected economists and related specialists from OSA, OCE, BERH, IWR and other installations with civil works functions together with IWR consultants (POD, CERC, HEC, WES, CERL and CRREL optional).

(2) One economist from each Division and District office as desired by the Division or District Engineer. Where attendance by more than one economist is desired, approval must be obtained from IWR, Center for Economic Studies. This is necessary as the size of the conference, as approved, is limited.

d. Location. Flagship Hotel, On the Pier, Galveston, Texas 77550. Phone: 713-762-8681.

e. Time. March 22 through 24, 1972. Opening sessions will begin at 9:00 a.m. on Wednesday, 22 March, and closing session will conclude at 4:00 p.m. on Friday, 24 March 1972.

f. Accommodations. Room rates are $13.50 for singles and $16.50 for doubles. Participants are urged to write direct to the hotel for reservations giving your name, single or double room desired, dates of arrival and departure. Limousine transportation service between Houston International Airport and Flagship Hotel is available hourly at $7.50 per person.

g. Agenda. The program will consist of an opening general session, workshops covering specific research areas and a closing general session.

(1) The opening session will include a discussion of:

(a) Water Resources Council's proposed Principles and Standards.

(b) Preparation of guidelines required under Section 122 of the Rivers and Harbors Act of 1970.

(c) Improved Methods for Flood Control Evaluation.

(d) Current Economic Research in the Institute for Water Resources.

(e) Translation and Application of Research Results.

(2) Following the opening session, there will be separate workshops covering research underway and needed in each of the following areas:

(a) Navigation and port development.

(b) Flood control and flood plain management.

(c) Water supply and quality.

(d) Water-oriented recreation.

(e) Measuring the economic and social impact of water resources development.

(f) Evaluation of the needs for water resources development.

(3) The closing session will be devoted to oral reports from each workshop chairman including matters covered, conclusions and recommendations, together with appropriate discussion from the floor.

h. Output. Conference proceedings will be published by the IWR and will contain the papers presented at the general sessions and summaries of the workshop discussions.

4. Action Required. Each office to which this circular applies will provide the following information to the Institute for Water Resources (ATTN: IWRES), 2461 Eisenhower Avenue, Alexandria, Virginia 22314, no later than 28 February 1972:

a. The name of individual(s) nominated for the conference. Indicate for each nominee three choices of the workshop assignments from among the topics listed in paragraph 3g(2).

b. In addition, each office may suggest additional topics for workshop discussion and submit papers for consideration in the conference workshops.

5. Costs. Travel and per diem costs will be assumed by participating offices. IWR will assume responsibility for conference facilities and for invited consultants.

6. Additional Information. Any questions pertaining to this circular should be addressed to James Tang, Institute for Water Resources (Phone: 202-325-0478).

FOR THE CHIEF OF ENGINEERS:

RICHARD F. McADOO
Colonel, Corps of Engineers
Executive

PROGRAM SCHEDULE

CONFERENCE FOR ECONOMISTS OF THE CORPS OF ENGINEERS

22-24 March 1972
Flagship Hotel-on-the-Pier, Galveston

(All General Sessions at Outrigger Room. Rooms for workshops will be announced before meetings.)

21 March, Tuesday

7:00 - 9:00 p.m.	Advanced Registration (Outrigger Room)

22 March, Wednesday

8:00	Registration
9:00 - 9:30	Welcome: COL N. C. Rhodes Statement: BG K. B. Cooper Purpose of Meeting: Bob Harrison
9:30 - 10:00	General Session: Special Presentations: Jim Tozzi: Program Priority in Civil Works Jack R. Sheaffer: Corps Involvement in Urban Studies
10:00 - 10:15	Coffee Break
10:15 - 12:15	Bill Donovan (assisted by Panelists: Werner, Tozzi, Harrison, Kalter): Proposed Principles and Standards by Water Resources Council & Guidelines Required under Section #122 of the Rivers and Harbors Act, 1970
12:15 - 1:30	Lunch
1:30 - 3:00	General Session: Ed Cohn: New Procedures for Evaluation of Flood Control Benefits Ed Schiffers: Use of Indicators and Their Application to Making Projections George Phippen: Economic Costs of Flood Plain Regulation Jim Tang: Flood Plain Management Research Paul Fredericks: Flood Plain Management Experience in Pullman, Washington

22 March, Wednesday (Cont'd)

3:00 - 3:15	Coffee Break
3:15 - 5:00	General Sessions:
	Nat Back: Economic and Social Impact of Water Resources Development George Antle: Assessment of the Needs for Water Resources Development Bob Fulton: WRC 2nd National Assessment George Antle: Arkansas River Basin Project Study
7:00 - 9:00	Discussion Session on Interdisciplinary Career Development Program, Suite No. 2

23 March, Thursday

9:00 - 10:15	General Sessions:
	Bob Harrison: Water Quality and Water Supply Howard Olson: Analytical Systems for Navigation Keith Adams: Systems Analysis for Inland Waterways George Makela: Deep-water Port Development
10:15 - 10:30	Coffee Break
10:30 - 12:15	General Sessions (continued)
	Brion Sasaki: Experiments with Discriminant Analysis Richard McDonald: Research in Social and Environmental Aspects of Planning James Tang: Problems and Issues in Water-oriented Recreation Research
12:15 - 1:30	Lunch
1:30 - 5:00	Concurrent Workshop Sessions (3:00 - 3:15 Coffee Break)
	Workshop No. 1, Navigation and Port Development. Discussion Leader: Howard Olson
	Workshop No. 2, Water-based Recreation Research. Discussion Leader: Jim Tang
	Workshop No. 3, Multipurpose Planning, Discussion Leader: George Antle
7:00 - 9:00	Continuous Workshop Discussion as needed, Suite No. 2

24 March, Friday

9:00 - 12:15	Concurrent Workshop Sessions (10:00 - 10:15 Coffee Break)
	Workshop No. 4, Water Quality and Water Supply. Discussion Leader: Bob Harrison
	Workshop No. 5, Flood Control and Flood Plain Management. Discussion Leader: Ed Cohn
	Workshop No. 6, Impact Studies. Discussion Leader: George Antle
1:30 - 4:00	Remarks: COL R. R. Werner
	General Sessions: Workshop Reports

ALPHABETICAL LIST OF ATTENDEES

ECONOMISTS CONFERENCE

NAME	
Keith Adams	Board of Engineers for Rivers & Harbors
Jay C. Anderson	Consultant, Utah State
Thomas Anderson	Baltimore District
George Antle	Institute for Water Resources
N. Arvanitidis	Consultant, Menlo Park, California
Joe Auberg	Missouri River Division
Nat Back	Consultant, Alexandria, Virginia
Col. Richard Batson	Institute for Water Resources
Owen Belcher	South Atlantic Division
John Bogue	Los Angeles District
Eric Bovet	Consultant, Arlington, Virginia
Jo Carroll	Consultant, Penn State
Ed Cohn	Office of Chief of Engineers
BG Kenneth B. Cooper	Office of Chief of Engineers
Andre Corbeau	Consultant, University of Missouri
Jim Cunningham	Fort Worth District
Robert Daniel	Omaha District
Lawrence Davidoski	North Atlantic Division
Bertrand de Frondeville	Consultant, Arthur D. Little Co.
Arlene Dietz	Chicago District
Bill Donovan	Office of Chief of Engineers
Edward Dozier	Norfolk District
Albert Dykes	Nashville District
Betty Mae Eberhardt	New Orleans District
Wayne Ehlers	Ohio River Division
A. Elberfeld	Huntington District
W. H. Eldridge	Galveston District
Paul Fredericks	Walla Walla District
Roger Freeman	Galveston District
Bob Fulton	Office of Chief of Engineers
Gary Fuqua	Portland District
Homer Gardner	Lower Mississippi Valley Division
Art Harnisch	Seattle District
Bob Harrison	Institute for Water Resources
William Hearrean	Kansas City District
William Hicks	Lower Mississippi Valley Division
Roderic Hill	Sacramento District
William Hobgood	Vicksburg District
Ivan Hobson	Southwestern Division
Judy Hourigan	Institute of Water Resources

ALPHABETICAL LIST OF ATTENDEES Con't

ECONOMISTS CONFERENCE

NAME	
Frank Incaprera	Galveston District
Everett Johnson, Jr	New Orleans District
Nahor Johnson	New York District
Ralph Jones	Albuquerque District
Robert Kalter	Consultant, Cornell University
H. King	Louisville District
William Leininger	Consultant, Washington, D.C.
Jim Lew	San Francisco District
George Makela	Institute for Water Resources
David Mann	St Paul District
Lawrence Maraoka	Pacific Ocean Division
~~Lyle Marlot~~	Wilmington District
Leonard Merewitz	Consultant, University of California
Hubert Miles	Savannah District
Virgil Miller	Galveston District
William Morse	Rock Island District
Richard McDonald	Institute for Water Resources
Robert MacLauchlin	North Central Division
Anita Nelson	Office of Chief of Engineers
T. Odle	Detroit District
Howard Olson	Institute for Water Resources
J. F. O'Rourke	Galveston District
George Phippin	Office of Chief of Engineers
Irwin Reisler	Office of Chief of Engineers
Col. Nolan C. Rhodes	Galveston District
M. Ritter	Jacksonville District
Ronald Roberts	St Louis District
Wilfred Sanderson	Pittsburg District
Brion Sasaki	Institute for Water Resources
Francis Sharp	St Louis District
Jack Sheaffer	Office, Secretary of the Army
H. Shoudy	Buffalo District
George Smith	Mobile District
Paul Soyke	Rock Island District
John Sparlin	Tulsa District
Cecil Sparks	Southwestern Division
Ray Struyk	Consultant, Rice University
Norman Swenson	Memphis District
James Tang	Institute for Water Resources
William Torget	North Pacific Division

ECONOMISTS CONFERENCE

NAME	
James Tozzi	Office, Secretary of the Army
James Warren	Galveston District
Ruben Weisz	Consultant, University of Arizona
Charles Welling	Alaska District
Col. Robert Werner	Office of Chief of Engineers
Leonard White	Consultant, University of Arizona
Janet Wildman	New England Division
Edward Wisniewski	Philadelphia District
Walter Yep	South Pacific Division
Geroge Zimmerman	Little Rock District